# Table of Contents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Site Selection</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Installation</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Siren Features</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>Operating the Siren</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>Maintenance</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Theory of Operation</td>
<td>11</td>
</tr>
<tr>
<td>8</td>
<td>Troubleshooting</td>
<td>20</td>
</tr>
<tr>
<td>9</td>
<td>Specifications</td>
<td>27</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

The WAVE product line provides fully automated operation of audible and visual lightning notification and lightning equipment protection schemes. 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.

The WAVE Transmitter, which is typically connected to the Strike Guard Lightning Warning System, transmits 27 MHz, digitally encoded radio messages to provide automated warning of electrical storms, as well as electrical isolation of sensitive equipment.

The intelligent design of the Strike Guard Lightning Warning System and WAVE products make for an unbeatable combination of innovation and value.
CHAPTER 2
SITE SELECTION

The Siren Mounting Plate can be mounted on a wooden post or mast, on the side of a building, or on a tripod mast. The Siren is designed to be mounted in an elevated position, twelve or more feet above ground level. When choosing locations for Siren Stations, the following should be considered:

Audible Range: from what distance must the Siren be heard.
Radio Reception: factors limiting radio communication.
Visibility: optimal placement for the optional strobe lamp.

AUDIBLE RANGE

A properly mounted Siren horn has a rated sound pressure level (SPL) of 130 dB at 3 meters. As a general rule, the maximum range of the horn is where the measured SPL drops to 80 dB. The following graph shows this range for the WAVE horn in yards.

The 80 dB point falls between 1000 and 1100 yards.
Each Siren Station can operate up to four horns. And each Siren horn can be mounted to face a specific direction. Each horn will cover an angle of between 90 and 120 degrees. Therefore, a single Siren Station configured with four horns, located in a site with minimal obstructions will provide an audible signal over a circular area with a radius of cerca 1000 yards, depending on conditions. With this in mind, place markers on a scaled map layout for the area of interest to identify potential locations for the Siren Stations. Keep in mind that any significant obstructions at a potential site, such as buildings or thick groves of trees will block or attenuate the audio signal.

**RADIO RECEPTION**

Potential remote siren sites should be evaluated for radio reception. Ideal radio reception is realized with a clear line-of-sight between the WAVE Transmitter antenna and the Siren antenna. The WAVE Transmitter outputs a 10 Watt signal with an optimal range of 10 miles. However, the terrain, vegetation and building structures at most potential sites will reduce this range by some degree.

Refine each potential site by minimizing the amount of structures and thick vegetation between the Transmitter and Siren. The Siren is equipped with a standard 8 inch whip antenna. For Siren sites with marginal reception, an optional 3-foot high-gain antenna with an extension cable is available.

**VISIBILITY**

For those cases where someone does not recognize the Siren horn sounding because they are in a noisy environment, or within the shelter of a building when the alarm signal is sounded, a visible warning is recommended. The optional Siren strobe produces continuous high intensity flashes for the duration of the alarm state.

The Siren should be mounted such that the lamp is plainly visible to personnel who are the most likely to miss hearing the audible warning. Mounting the strobe above and behind the Siren station can provide 360 degree viewing.

**Note:** The strobe lamp generates a high intensity optical pulse which can interfere with the Strike Guard Sensor. Ideally, the strobe lamp should be mounted such that it is not visible to the Strike Guard.
CHAPTER 3
INSTALLATION

The WAVE Siren is designed for ease of installation and includes the necessary hardware. However, the customer will need to prepare the site for the electrical and ground connections for the Siren, beforehand. The following text assumes that the mounting post and external power source have already been installed.

NECESSARY TOOLS AND EQUIPMENT

Ladder: to access location for mounting the Siren
Wrench 1/2": secure Horns to Mount Plate and secure Mount Plate to wooden post
Cordless Drill: make pilot holes for lag screws
Nutdriver 5/16": secure Siren to Mount Plate
Nutdriver ½": secure Mount Plate to wooden post
Solid Copper 8 AWG: connect Siren to earth ground
Wire Strippers: to prepare electrical cables

ORDER OF INSTALLATION

1. Prepare wooden post for the Siren Mount Plate; make 0.25” pilot holes using the Mount Plate as a template.
2. Secure Siren Mount Plate to wooden post with 5/16 x 2.5” lag screws, provided.
3. Secure Siren to Siren Mount Plate with #10-32 screws, provided.
4. Secure horns to Siren Mount Plate with 5/16-18 hex nuts, provided.
5. Secure strobe lamp, if used, to either Mount Plate or wooden post.
6. Connect earth ground from the ground rod to the Siren and Mount Plate using ground lugs provided.
7. Install battery in the Siren Station and connect the red and black battery wires to the red and black battery terminals, respectively.
8. Connect the horns and strobe to the Siren Station using the keyed, quick connects provided.
9. Connect external power to the Siren Station using the keyed, 3-pin quick connects provided.
VERIFY OPERATION

Upon connection of external power, the Siren goes through a power-up sequence. The external LED flashes green after a normal power-up sequence without errors. If the external LED does not flash, the Siren has failed to power-up. In this case, momentarily press the green On-Off button on the Siren's Processor Board. Within five seconds, the LED should flash green.

**Note**: if the external LED either does not flash, or flashes red, there is a problem. See Section 8 on troubleshooting. For further assistance, contact Wxline.

If the Transmitter is fully installed, arrange to activate the Siren via radio commands from the Transmitter. There are three basic methods to activate Radio commands for Siren tones:

- Automatically, via the Control Input
- Manually, by the Transmitter keyswitch
- Manually, by the Transmitter menu

During normal operation, the Transmitter detects state changes to relay contacts to automatically generate radio messages. Typically, the relay is part of the Strike Guard Lightning Data Receiver, to indicate when entering or exiting a lightning alarm state.

Radio messages for Siren tones are activated manually at the Transmitter via the Transmitter keyswitch and the Manual Select four-position switch. One of four possible tones are selected via the Manual Select switch. The keyswitch is then rotated a ¼ turn momentarily to transmit the selected Siren message.

Radio messages to control the strobe lamp the WAVE Power Sequencer are available via menus in the Transmitter's multi-purpose screen. Please refer to the Transmitter User Guide to sound the horns and control the strobe lamp, if present.

**Note**: the noise level of the Siren horn is 130 dB at 3 meters; wear ear protection to avoid loss of hearing.

**Note**: if the Siren does not respond to the Transmitter alarm signals, there is a problem. See Section 8 on troubleshooting. For further assistance, contact Wxline.
CHAPTER 4
SIREN FEATURES

EXTERNAL LED
An external LED indicates the general status of the WAVE Siren. During normal operation, the LED flashes green. To signal an error or problem, the LED flashes red. A bank of LEDs inside the unit provide specific error codes to assist in diagnosing problems.

Note: When receiving a valid radio command from the WAVE Transmitter, the external LED will illuminate as yellow for about two seconds and then return to flashing either green or red to indicate the Siren’s general status. This is useful when verifying the Siren’s radio reception.

EXTERNAL ANTENNA
An external antenna enables radio reception from the WAVE Transmitter. The standard antenna is an 8 inch whip model. For Sirens with marginal reception, an optional 3 foot model with an extension cable and mounting hardware is available. The antenna attaches to the Siren via a PL-259 connector.

EXTERNAL CONNECTORS
The cable connections for power, the horns and optional strobe allow for a quick, easy connection during the installation and are keyed to prevent the station from being mis-wired. The connectors have a locking mechanism and are weatherized for reliable outdoor service. The connectors simplify removal of the Siren, should it become necessary to move the station, or return it for service.

A ground-lug connector on the rear of the Siren allows connection of the Siren chassis to earth ground.

INTERNAL ON-OFF SWITCH
The green momentary contact switch near the center of the Processor Board allows the user to power the Siren Station ON or OFF.

• To turn the Siren OFF: Press the switch continuously for five or more seconds and then release.
• To turn the Siren ON: Press the switch momentarily.

Note: The Siren powers-on when connected to external power, without using the on-off switch.
DIAGNOSTIC LEDS

The multi-purpose LED array near the top of the Processor Board serves to indicate a normal power-up sequence, errors via internal diagnostics, status of the strobe function during an alarm state and status of the manual test, when it is activated. LEDs functions are defined in Section 7, Theory of Operation.

CONFIGURATION SWITCHES

Two banks of 8-position DIP switches near the top of the Processor Board allow the user to configure the Siren in a variety of ways: the number of horns, the type and duration of horn tones and the source of external power. One of the switches activates the manual test of the Siren Station. DIP switch functions are defined in Section 7, Theory of Operation.

RADIO ADDRESS SWITCHES

The Radio Board, which is mounted on the lower-right section of the Processor Board, has two banks of 8-position DIP switches.

Note: a corresponding pair of DIP switches reside in the WAVE Transmitter, behind the main circuit board. The switch pattern for each Siren must agree with that of the Transmitter in order to function, properly.
CHAPTER 5
OPERATING THE SIREN

The Siren is designed to be controlled remotely by the WAVE Transmitter. So, a complete functional test of the Siren is done in conjunction with the WAVE Transmitter. Four distinct audible tones are activated manually by radio messages via the Transmitter keyswitch. The strobe lamp is activated manually by radio messages via the Transmitter menu.

MANUAL TEST

A partial, standalone test can be performed at the Siren via a manual test. On the Processor Board, Switch # 8 of Switch Bank 2 activates a manual test of the audio amplifier and the optional strobe lamp. Switch # 8 of Switch Bank 2 is a toggle switch; changing the switch position, regardless of its initial position, initiates a manual test. A description of the manual test is given in Section 7, Troubleshooting.

Note: The WAVE Siren horns output audible tones rated at 130 dB at 3 meters. Please use hearing protection when sounding the Siren horns.

CONFIGURATION SWITCHES

Siren configuration is done via two DIP switch banks near the top-right portion of the Processor Board. These switch banks are labeled Setup One and Setup Two. Switch configurations are assigned, as follows:

<table>
<thead>
<tr>
<th>Setup 1</th>
<th>Setup 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch #</td>
<td></td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8</td>
<td>1 2 3 4 5 6 7 8</td>
</tr>
<tr>
<td>Horn Duration</td>
<td>External Power</td>
</tr>
<tr>
<td>Tone 3</td>
<td>Strobe Only</td>
</tr>
<tr>
<td>Tone 4</td>
<td>Number of Horns</td>
</tr>
<tr>
<td>All Clear Tone</td>
<td>Interface</td>
</tr>
<tr>
<td>Alarm Tone</td>
<td>Hardware Type</td>
</tr>
<tr>
<td></td>
<td>Comm Test</td>
</tr>
<tr>
<td></td>
<td>Manual Test</td>
</tr>
</tbody>
</table>

RADIO ADDRESS SWITCHES

The radio address switches reside on the Radio Receiver Board. The switch setting functions as the radio address for the system the Siren belongs to. The address switch setting is a binary pattern that translates to an integer, which ranges from 0 – 65,635. Note that the radio address must agree with that of the Transmitter in order to receive messages.
CHAPTER 6

MAINTENANCE

General maintenance and inspection should be done, periodically.

**Note:** To reduce shock hazards, disconnect AC external power prior to working inside the Siren station.

**BATTERY**

In general, the battery should be replaced each year. Note that battery life will vary according to the number of discharge cycles and the amount of time it is subjected to extreme temperatures.

**DESICCANT**

The Siren is shipped with three, four unit bags of desiccant to keep the electronics dry. Because the Siren enclosure is air-tight, desiccant keeps the electronics dry if any moist air trapped inside condenses. Replace the desiccant each year.

**Note:** Do not run the Siren without desiccant!

**GROUND CONNECTION**

The earth ground connections should be inspected, annually. Inspect the wire and ground lugs on the rear of the Siren Station and on the bottom of the Mount Plate for oxidation; replace as necessary.

Inspect the clamp and the wire on the ground rod; replace as necessary.

**CABLES FOR HORN AND STROBE**

Inspect the cables and interconnects between the Siren and the horns and optional strobe, if present. Connectors or cables that are damaged should be repaired or replaced. Contact Wxline to service the affected components.

**Note:** the noise level of the Siren horn is 130 dB at 3 meters; power-down the Siren and disconnect the battery to protect hearing while inspecting or servicing the horns.

**HORNS**

Inspect Siren horns for obstructions in the bell and nose cone areas for insects, leaves, etc.; clean as necessary.

**Note:** the noise level of the Siren horn is 130 dB at 3 meters; power-down the Siren and disconnect the battery to protect hearing while inspecting and cleaning the horns.
CHAPTER 7
THEORY OF OPERATION

This chapter describes the theory of the WAVE Siren operation.

The WAVE Siren consists of four main components:

Radio Receiver detects and decodes RF messages from the WAVE Transmitter.

Audio Amplifier when activated, drives the horns to provide the audible signals at a noise level of 130 dB at 3 meters.

Processor Board manages the battery charger, the audio amplifier, the optional strobe lamp and internal diagnostics.

Battery provides backup power for the Siren and the bulk of power for the audio amplifier.

Note: To reduce shock hazards, disconnect AC external power prior to working inside the Siren station.

RADIO RECEIVER

The Radio Receiver provides reliable reception of broadcast messages from the WAVE Transmitter. The Transmitter output is a digitally encoded 10 watt signal at 27.255 MHz. Messages are briefly transmitted, as necessary. FCC license registration is not required.

Each Radio Receiver has a configurable radio address, set to agree with that of the WAVE Transmitter for a given system. Two banks of DIP switches allow for 65,536 possible address settings. Therefore, several WAVE systems may operate in close proximity to one other without conflict.

The Radio Receiver Board and the Processor Board are configured at the Wxline factory to indicate a communication error if the Siren fails to register a valid message from the WAVE Transmitter within four hours. Note that the WAVE Transmitter broadcasts a test message once per hour.

The Radio Receiver has two LEDs: a green LED indicates the presence of DC power and a red LED indicates the presence of an RF signal. The green LED is ON during normal operation. The red LED is normally OFF and flashes on briefly during reception of RF messages from the WAVE Transmitter.

Relative RF signal strength can be measured in the field via a test point on the Radio Receiver PWB. Upon reception of an RF message, the receiver momentarily converts the signal strength to a DC level. A signal of –40 dBm generates 7.10 VDC at the test point.
The Radio Receiver PWB is shown in the figure, below.

The Radio Receiver is connected to an external antenna via a short length of RG-174 coax cable and an SO-239 (UHF female) connector. The standard antenna is an 8 inch whip version that mates directly to the UHF connector on the WAVE Siren enclosure. For installations with marginal radio reception, a 3-foot whip antenna with an extension cable is available for improved sensitivity.

The Radio Receiver has four Form C type relays, mounted just above the Power & Output Terminal Block. For each proper RF message that is detected, the receiver momentarily activates a corresponding relay pattern, which is interpreted by the Processor Board as a radio command.

The Radio Receiver is interfaced to the Processor Board via a right-angle connector and the Power & Output Terminal Block; it is through this connection that power is supplied to the Radio Receiver and relay patterns are read by the Processor Board.

**AUDIO AMPLIFIER**

The audio amplifier generates the siren tones and drives the horns to a sound level of 130 dB at 3 meters. The amplifier is managed by the Processor Board, which controls DC power to the amplifier, the type and duration of siren tone and the sequential activation of each horn. To conserve power, the amplifier is normally OFF; the amplifier is only ON when siren tones are generated. A master on/off switch on the front panel of the amplifier is a two-position push-button switch, which must be in the ON (down) position for normal operation.
The 12 Volt battery supplies the bulk of the current to the audio amplifier when driving the Horns and must be connected during normal operation.

The audio amplifier’s input power and audio output are connected to the Processor Board via a 4-pin connector beneath the audio amplifier. Activation of siren tones are made via the black amplifier cable, which is tied to the Processor Board via a small, 2-conductor screw terminal block near the 12 Volt battery.

**PROCESSOR BOARD**

The Processor Board is the master control of the Siren Station, managing the battery charger, the audio amplifier, sequential activation of the horns, the optional strobe lamp and internal diagnostics. The Processor Board reads interpreted messages from Radio PWB and then takes the appropriate action to control the horns and the strobe lamp.

The layout of the Processor Board is shown in the figure, below.

---

**Configuration**

Siren configuration is done via two DIP switch banks: Setup 1 and Setup 2. Switches for Setup 2 are assigned, as follows:

<table>
<thead>
<tr>
<th>Switch #</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strobe Only</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Horns</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardware Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comm Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Setup 2, Switch 1

This switch position determines the type of external power available: solar or AC. Setting this switch ON selects solar power; the off position selects AC external power.

Note that when configured for solar power, external power is unavailable at night and restored during daylight hours. Since this is a normal daily cycle, the Siren does not post an error when external power is lost after sunset, but rather, flashes the external LED green at a lower duty-cycle of once per five seconds to conserve battery power.

In addition, a Siren Station configured for solar power uses a larger, 12 Amp-Hour battery for additional capacity during the evening hours.

Setup 2, Switch 2

Switch 2 enables the function of sounding the horns; it is normally in the ON position. This switch is configured in the OFF position for the special case of a Siren station controlling a strobe lamp, but no horns. This special, strobe only case, allows the Siren station to immediately activate the strobe lamp, without waiting for all horns to sound first.

Setup 2, Switches 3 & 4

Switches 3 and 4 combined, configure the Siren station for the number of horns to be driven. Provided that Switch 2 is ON, the Siren will drive from one to four horns, with the switches set as follows:

<table>
<thead>
<tr>
<th>Switch #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 4</td>
<td>Number of Horns</td>
</tr>
<tr>
<td>Off Off</td>
<td>1</td>
</tr>
<tr>
<td>Off On</td>
<td>2</td>
</tr>
<tr>
<td>On Off</td>
<td>3</td>
</tr>
<tr>
<td>On On</td>
<td>4</td>
</tr>
</tbody>
</table>

Setup 2, Switches 5 and 6

These switches are reserved for future use. For firmware Version 3.0 and earlier, they have no effect.

Setup 2, Switch 7

Switch 7 enables the Communication Error Test. If the Radio Board flags a communication error, the Main Processor Board reports the error by illuminating D3 and then forces the external LED to flash red if Switch 7 is ON. If Switch 7 is OFF, the Main Processor Board will ignore communication errors flagged by the Radio Board.
**Setup 2, Switch 8**

This is a toggle switch; changing the switch position, regardless of its initial position, initiates a manual test. See the subsection in this chapter describing the Manual Test for a detailed description of this test.

**Setup 1, Switches 1 & 2**

When the Siren receives a command to activate the horns, it activates each horn, one at a time, in sequence. The duration that each horn sounds is determined by Switches 1 and 2 of the Setup 1 DIP switch bank. The options are 5, 8, 12 and 15 seconds per horn. The following table shows the relative switch positions for the respective horn durations.

<table>
<thead>
<tr>
<th>Switch #</th>
<th>Horn Duration (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Off Off</td>
<td>5</td>
</tr>
<tr>
<td>Off On</td>
<td>8</td>
</tr>
<tr>
<td>On Off</td>
<td>12</td>
</tr>
<tr>
<td>On On</td>
<td>15</td>
</tr>
</tbody>
</table>

**Setup 1, Switches 3 & 4**

The WAVE Transmitter has four distinct radio commands for activating the Siren horns via a manual keyswitch operation and are designated as: Alarm, Tone 2, Tone 3 and Clear. Switches 3 and 4 define how a particular Siren will respond to the radio commands with respect to Tone 2 and Tone 3, as follows:

<table>
<thead>
<tr>
<th>Switch #</th>
<th>Tone 3</th>
<th>Tone 2</th>
<th>WAVE Station Sound</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4</td>
<td></td>
<td>Traditional Police Siren</td>
</tr>
<tr>
<td>On</td>
<td>On</td>
<td></td>
<td>Ramping to Continuous</td>
</tr>
</tbody>
</table>

Note that Switch 3 configures Tone 3, while Switch 4 configures Tone 2. It is recommended that Tones 2 and 3 be distinct from each other; set the switches such that if one is ON, the other will be OFF.

**Setup 1, Switches 5 & 6**

Switches 5 and 6 define how the Siren will sound the horns when an All Clear command is received from the WAVE Transmitter. There are four distinct tones available, as defined in the following table:

<table>
<thead>
<tr>
<th>Switch #</th>
<th>All Clear</th>
<th>WAVE Station Sound</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 6</td>
<td></td>
<td>Horn-Siren-Horn-Siren</td>
</tr>
<tr>
<td>Off Off</td>
<td></td>
<td>Siren-Hi</td>
</tr>
<tr>
<td>On Off</td>
<td></td>
<td>Horn Continuous</td>
</tr>
<tr>
<td>On On</td>
<td></td>
<td>Horn Intermittent</td>
</tr>
</tbody>
</table>
Setup 1, Switches 7 & 8

Switches 7 and 8 define how the Siren will sound the horns when an Alarm command is received from the WAVE Transmitter. There are four distinct tones available, as defined in the following table:

<table>
<thead>
<tr>
<th>Setup 1 WAVE Station Sound</th>
<th>Alarm Switch #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Horn-Siren-Horn-Siren</td>
<td>Off</td>
</tr>
<tr>
<td>Siren-Hi</td>
<td>Off</td>
</tr>
<tr>
<td>Horn Continuous</td>
<td>On</td>
</tr>
<tr>
<td>Horn Intermittent</td>
<td>On</td>
</tr>
</tbody>
</table>

Note: It is recommended that the Alarm and All Clear tones be distinct from each other. Verify that the switch pattern for Switches 5 and 6 are different from the pattern for Switches 7 and 8.

Siren Status

An external LED indicates the general status of the Siren by flashing green for normal condition and red when an error is encountered. The external LED is connected to the Processor Board via a screw terminal block, on the right-hand side of the figure, above. During normal operation this LED flashes green and flashes red when an error is encountered. Upon receiving a valid radio message, the external LED momentarily flashes yellow for one second.

A bank of diagnostic LEDs, located on the upper-center portion of the Processor Board provide the following types of status indications:

- diagnostic errors when encountered
- strobe operation, when the strobe lamp is activated
- sequential horn activation during the audio amplifier’s manual test

The following table defines the LED states for each of the three functions.

<table>
<thead>
<tr>
<th>Diagostic Lights</th>
<th>Error Conditions</th>
<th>Strobe Function</th>
<th>Audio Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>D11</td>
<td>Power input not within specs.</td>
<td>Horn 1 = On</td>
<td></td>
</tr>
<tr>
<td>D10</td>
<td>Amplifier error on power-up.</td>
<td>Horn 2 = On</td>
<td></td>
</tr>
<tr>
<td>D9</td>
<td>TBD</td>
<td>Stobe current detected.</td>
<td>Horn 3 = On</td>
</tr>
<tr>
<td>D8</td>
<td>Battery self-test has failed.</td>
<td>Voltage applied to strobe.</td>
<td>Horn 4 = On</td>
</tr>
<tr>
<td>D7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D3</td>
<td>Communications error - no valid message received during past 4 hours.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Error Conditions**

As soon as an error is registered, the microprocessor illuminates the corresponding diagnostic LED and forces the external status LED to flash red. Error conditions are explained in Section 8, Troubleshooting.

**Strobe Function**

A strobe lamp provides visual warning during an alarm state. The Siren may be configured to activate horns plus a strobe lamp, or to operate a strobe lamp without any horns. The Siren drives the strobe with the 12 VDC battery voltage.

When activated, the strobe lamp flashes at a rate between 70 – 90 times per minute. During this time, the Processor Board activates LEDs D8 and D9 to indicate voltage present and strobe lamp current, respectively. Voltage is continuously available to the strobe lamp during the alarm period. However, the strobe lamp draws current, only as necessary to create momentary flashes in the xenon lamp. Therefore, during the alarm period, D8 is illuminated continuously and D9 flashes on and off in a complementary fashion with the strobe lamp.

**Manual Test**

The following description is valid for Version 3.0 firmware in the WAVE Siren.

The Siren can be forced to perform a functional test to activate the horns, as well as the strobe lamp. During the test, power is applied to the audio amplifier, with each horn connected to the amplifier, one at a time, sequentially. At the same time, the strobe lamp is activated for the duration of the test.

To start the test, Switch 8 of the Setup 2 DIP switch bank is toggled. That is, change the switch position, regardless of the position it initially is in. While the test is in progress, toggling the switch has no further effect until the test is complete. After the test, another toggle of the switch starts a new test.

During the test, LEDs D11, D10, D9 and D8 indicate when horns 1, 2, 3 and 4 are connected to the audio amplifier, respectively. Each LED turns on sequentially, with only one LED illuminated at any given time. The test cycles through all four LEDs, regardless of how many horns the Siren is configured to operate.
The duration that each horn is connected to the audio amplifier is determined by Switches 1 and 2 of the Setup 1 DIP switch bank. These switches function for the Manual Test identically to that of normal operation. The table defining the switch positions is repeated here for reference.

<table>
<thead>
<tr>
<th>Setup 1 Switch #</th>
<th>Horn Duration (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Off</td>
<td>5</td>
</tr>
<tr>
<td>1 Off On</td>
<td>8</td>
</tr>
<tr>
<td>1 On Off</td>
<td>12</td>
</tr>
<tr>
<td>1 On On</td>
<td>15</td>
</tr>
</tbody>
</table>

Note that the horns do not sound automatically during the test; the user must manipulate the momentary SIREN-HORN switch on the face of the audio amplifier, or press the YELP button to output a tone from the audio amplifier.

The momentary switch on the Audio Amplifier has three positions: SIREN, OFF and HORN. The switch is spring-loaded, such that it automatically returns to the Off or center position when released. The Horn position is selected by rocking the switch away from the HORN label on the front panel. In this case, the audio amplifier generates a flat monotone, which turns off as soon as the switch is released. However, the Siren tone produces a standard police wail for about five seconds after the switch has been released. The Siren position is selected by rocking the switch away from the SIREN label.

If the YELP button is pressed, it will sound continuously for the duration of the test, unless the user activates the momentary switch. The Yelp function is a convenient means to cycle through all of the available horns during the manual test.

Please note that when Horns connected to the Siren, the 12 V battery should be connected. The battery provides the current needed to drive the audio amplifier when Siren Horns are connected.

**BATTERY**

The battery provides the bulk of the power for the audio amplifier when driving the horns and serves as backup power for the Siren when external power is interrupted. External power provides DC power to the low power circuitry in the Siren and for recharging the battery. External power also complements the battery when driving the horns.

There are two versions of the battery, depending on the configuration of the Siren. A 12 Volt, 7.5 Amp-Hour model is used for AC external power. And a 12 Volt, 12 Amp-Hour version is used for Solar power. The larger capacity battery is used in the solar power configuration to compensate for the inability to recharge during overcast conditions and the darkness of night.
A switch setting configures the Processor Board for either solar or AC external power to manage the different charge and discharge characteristics between the two battery models. In addition, a Siren configured for AC power will indicate an error when external power is lost. Whereas a Siren configured for solar power will not indicate such an error, since loss of external power is normal for solar power during the night. Instead, a solar-powered Siren will flash the external LED at a lower duty-cycle of once per five seconds to indicate loss of external power and to conserve battery power.

The battery is fused to protect the audio amplifier and Processor Board in the case of a short circuit fault.

Solar power units use a solar panel model that is between 50 and 60 watts and provides between 15 and 22 Volts DC to the Siren Station’s Processor Board.
CHAPTER 8
TROUBLESHOOTING

The WAVE Siren responds to radio messages from the WAVE Transmitter. This section assumes that the Transmitter function has been verified and that the following symptoms are due to a fault at the Siren Station.

**Note:** To reduce shock hazards, disconnect AC external power prior to working inside the Siren station.

**NO HORNS, NO STROBE**

**Radio Configuration**

The Radio Receiver Board has a configurable RF address, which must be set to agree with that of the WAVE Transmitter in order to recognize Transmitter messages. Verify the address switch settings of the WAVE Transmitter and Siren Station agree with each other. The Radio Receiver PWB is shown in the figure, below.

![Radio Receiver PWB](image)

**Radio Signal Reception**

Weak RF signal strength may cause the Siren to miss messages from the Transmitter. Signal strength can be measured in the field via a test point on the Radio Receiver PWB using either a VOM or a DMM with a max. voltage capture feature. The max. possible SS is represented by 7.1 VDC. A measured DC level of 5.0 Volts or more will provide normal operation. If the measurement is less than 5.0 VDC with a standard 8 inch whip antenna, an extended range antenna is recommended.
The Radio Receiver has two LEDs for diagnostics and troubleshooting. A green LED indicates the presence of DC power and a red LED indicates the presence of an RF signal. The green LED is ON during normal operation. The red LED is normally OFF and flashes on briefly during reception of RF messages from the WAVE Transmitter. A red LED that is actively on suggests the presence of ambient RF noise, or interference.

**NO HORNS, STROBE IS OK**

**Audio Amplifier**

A master on/off switch on the front panel of the amplifier can be inadvertently turned OFF during the installation or maintenance, which will silence the Siren. This two-position push-button switch should be in the ON (down) position for normal operation. A Siren powered-up with the amplifier’s master switch off will indicate an error with the audio amplifier.

Occasionally, physical shock during shipment may cause the audio amplifier to disconnect from the Processor Board. Verify the amplifier connector is mated properly to the main board.

The audio amplifier can be verified with a Manual Test of the Processor Board.

**DIP Switch Configuration**

On the Processor Board, Switch 2 of SETUP 2 should be ON (up) to enable the horn function. When in the OFF (down) position, the horns are disabled and only the Strobe will function. This is valid for the special case of a Siren configured for *strobe only* operation.

**BRIEF SOUND FROM HORNS, STROBE IS OK**

**Battery Fuse**

When sounding the horns, the audio amplifier is powered mainly by the +12 V battery. An inline fuse to the battery protects the Processor Board in the event of a failure. This fuse may fail from fatigue. The fuse can be checked for continuity with the power OFF and the battery disconnected. If open, the fuse can be replaced with the spare fuse, mounted nearby.

**Audio Amplifier**

If the audio amplifier draws excessive current, the fuse will open to protect the Processor Board. In this case, the glass fuse element is visibly open. In this case, the audio amplifier should be replaced.

**Note:** when sounding the horns with an open battery fuse, the WAVE Siren may turn itself off.
HORNS OK, NO STROBE

Strobe Lamp

The strobe lamp is powered mainly by the +12 V battery. When the Siren
receives a radio message to activate the strobe, it provides battery voltage to
the Strobe Lamp Assembly. The Siren also provides battery voltage to the
strobe during the Manual Test. In either case, the presence of +12 VDC to
+13.8 VDC should be confirmed using a voltmeter. If the correct voltage is
present, the problem is with the strobe, or the connection to it. The strobe
voltage can be measured at the Strobe Output screw terminals, near the
green On/Off momentary switch near the center of the Processor Board.

Note: LED D8 on the Processor Board will illuminate if the Siren has properly
received a STROBE ON radio message.

Processor Board

If during the Manual Test the Processor Board fails to produce +12 VDC at the
Strobe Output screw terminals, then the problem is with the Processor Board.

Weak Radio Signal or Poor Reception

Confirm that the radio signal strength is sufficient to reliably received
messages from the WAVE Transmitter. See the end of this chapter
discussing Testing and Diagnostics of a Communication Error.

EXTERNAL LED FLASHES RED

Self-diagnostic tests are done at power-up and periodically, thereafter. If an
error is encountered during the tests, an internal LED is illuminated to identify
the type of failure, while the external bi-color LED changes from flashing green
to flashing red.
The bank of diagnostic LEDs, located on the upper-center portion of the Processor Board provide the following indications:

<table>
<thead>
<tr>
<th>Diagnostic Lights</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED #</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>D11</td>
</tr>
<tr>
<td>D10</td>
</tr>
<tr>
<td>D9</td>
</tr>
<tr>
<td>D8</td>
</tr>
<tr>
<td>D7</td>
</tr>
<tr>
<td>D6</td>
</tr>
<tr>
<td>D4</td>
</tr>
<tr>
<td>D3</td>
</tr>
</tbody>
</table>

Error conditions are explained, below.

**POWER INPUT**

The microprocessor continually measures the DC input voltage and determines if the values are within the acceptance limits. If not, diagnostic LED D11 illuminates. Note that loss of external power on an AC unit will produce this error.

**AUDIO AMPLIFIER**

On power-up, the microprocessor connects power to the audio amplifier and then forces a brief test signal through Horn 1. The test signal is so brief, that it is not usually audible to the human ear, yet the current is measureable by the microprocessor. If the value falls outside the acceptance limits, LED D10 illuminates and the external LED is forced to flash red. Please note that this error occurs if the master On/Off switch on the face of the audio amplifier is in the OFF (UP) position during power-up.

**BATTERY SELF-TEST**

The battery is measured once per day to verify:

- the voltage charge level is acceptable
- the rate of discharge under load is acceptable

If either of these parameters fail, LED D8 illuminates and the external LED is forced to flash red.

The battery level is normally somewhere between full charge and the battery cutoff voltage of 11.0 VDC. With primary power available, a fully charged battery voltage is about 13.65 VDC. A discharged battery may fail the battery
self-test while recharging. Therefore, the battery should be recharged for a full
day to confirm that it is failing.

Note: new batteries normally measure between 12.75 – 13.10 VDC. A battery
that has been left idle for several weeks before being installed may measure
lower than 12.75 VDC. In this case, the battery should be charged for a
minimum of four hours, prior to testing it with the horns. The Siren will
recharge the battery when connected to external power.

COMMUNICATIONS ERROR

The Radio Receiver Board and the Processor Board are configured at the
Wxline factory to indicate a communication error if the Siren fails to register a
valid message from the WAVE Transmitter within four hours. Note that the
WAVE Transmitter broadcasts a test message once per hour.

Radio Address Switch Setting

The most common cause for a communication error is an RF address setting
in the Siren that is set differently from that of the WAVE Transmitter. Verify
that the RF address switches are set to agree with each other. In a system
with multiple Sirens, all Sirens must be set to agree with the RF address of the
Transmitter.

Fault at WAVE Transmitter

A communication error can be caused by a weak radio signal from the
Transmitter. A common fault is in the antenna cable of the Transmitter, or
more rarely in the Transmitter Radio Board. Verifying and troubleshooting the
WAVE Transmitter are covered in more detail in the Transmitter User Guide.
**Blocked or Attenuated Radio Signal**

The radio signal can be blocked or attenuated by buildings or vegetation. Attenuation is also a function of the distance from the Transmitter. An attenuated signal may be overcome using an extended range antenna on the Siren Station.

The standard antenna for the Siren Station is an 8-inch whip model that provides adequate reception for most sites within one mile of the Transmitter. An optional 3-foot, extended range antenna enhances the Siren’s radio reception. The antenna is normally mounted within 10 feet of the Siren.

If the Siren radio reception is effectively shaded or blocked from the WAVE Transmitter, the Siren Station can be moved to an alternate location with a less obstructed view of the Transmitter. In general, good radio communication for the WAVE Siren requires a relatively clear line-of-sight between the Siren and Transmitter.

**Inoperative Radio Receiver Board**

Loss of radio reception may be due to a damaged Radio Receiver Board in the Siren. This problem is relatively rare and at the time of this writing has not been seen at new sites during installation.

**Testing and Diagnostics**

After attempting to clear the communication error, the Siren should be tested to verify the repair was effective. Assuming there are no other errors, the Siren will power-up with the external Status LED flashing green. To avoid the need of waiting for four hours to confirm the repair, a communication error can be set in the Siren manually, via the momentary On/Off switch.

To set the communication error, press the On/Off switch continuously for two to three seconds until LED “D3” illuminates. Stop pressing the On/Off switch as soon as D3 illuminates, to avoid shutting off the Siren.

Once the communication error has been set, any valid radio message received from the Transmitter will clear the communication error and cause the external LED to flash green. Valid messages are:

- Test Mode: Test Message
- Horns: Alarm, Tone 2, Tone 3, All Clear
- Strobe: On, Off
- Sequencer: On, Off

If the Siren fails to receive a valid message during the test, the Siren’s external LED continues to flash red.
The relative signal strength of the radio signal at the Siren can be measured on the Radio Receiver Board using a Digital Multi-Meter (DMM) that has a Min/Max capture function. The measurement is made at the RF SIGNAL STRENGTH test point on the Radio Receiver PWB, with reference to GROUND. Upon reception of an RF message, the receiver momentarily converts the signal strength to a DC level. A signal of –40 dBm generates 7.10 VDC at the test point. A measured DC level of 5.0 Volts or more will provide normal operation.

The Radio Receiver PWB is shown in the figure, below.

If intermittent Siren operation is observed and the measurement is less than 5.0 VDC, the suspect causes listed above should be investigated. Note that the radio address switch setting will not affect the relative signal strength measurement, but the other causes listed will.
# CHAPTER 9

## SPECIFICATIONS

- **Power Requirements:**
  - 90 – 264 VAC (standard)
  - 15 – 21 VDC (solar option)

- **Carrier Frequency:** 27.255 MHz

- **RF Sensitivity:** -115 dBm (or better)

- **RF Selectivity:** 8 KHz

- **RF Modulation:** FSK

- **Antenna Impedance:** 50 ohms

- **RF Addresses:** 65,536

- **Range:**
  - Std. 8 in. antenna: up to 1 mile
  - 3 ft. antenna: up to 5 miles
  - 18 ft. antenna: up to 10 miles

- **Audible Sound Level:** 130 dB at 3 meters

- **Strobe Flash Intensity:** 270 (effective candle power)

- **Strobe Flash Rate:** 70 – 90 flashes / minute

- **Strobe Current:** 760 mA @ 12 VDC (average)

- **Strobe Lamp:** Xenon