Revision

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STANLEY SOLUTIONS

AUTOWATERMANAGER INSTRUCTION MANUAL

AutoWaterManager

STANLEY SOLUTIONS

AutoWaterManager

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Table of Contents

List of Figures

List of Tables

Solid Solutions for a Fluid Problem; The AutoWaterManager

"If you want a stable friendship, get a horse."

The AutoWaterManager by Stanley Solutions is a comprehensive management interface for livestock water trough heaters. Incorporating real-time measurement and modeling algorithms with wireless network communications and control, the AutoWaterManager delivers significant energy savings while maintaining dependable system performance.

Combining simple interfaces with robust system models and modern programming application interfaces, the AutoWaterManager supports the needs of the home livestock owner.

Getting Started with the AutoWaterManager

The AutoWaterManager itself is a fully self-contained unit that interfaces wirelessly with intelligent outlets to manage the heating of water troughs in a distributed manner. The "Manager" interfaces with these intelligent outlets over a standard 2.4GHz Wi-Fi network that it hosts and manages itself. The Manager maintains two network interfaces, one for its local management functionality, and the other to provide additional networking capabilities including, but not limited to, providing convenient access to the web interface.

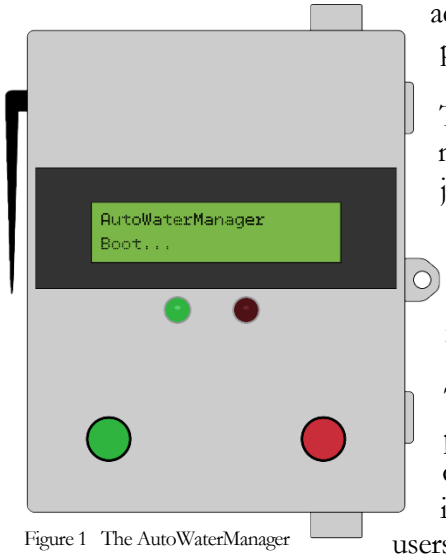

Figure 1 The AutoWaterManager

The AutoWaterManager aims to reduce active electrical load to a minimum, while maintaining maximum performance, heating water just over the threshold of freezing. It attempts to distribute electrical load evenly across the system, prioritizing troughs that are considered coldest. Priorities are ordered from lowest temperature to highest, leaving the colder troughs to be heated first.

Three user interfaces are provided with the AutoWaterManager to provide reliable and versatile control. Access to settings and configuration is granted through two of the three interfaces, the web interface and the RESTful API. It is through both interfaces that users can change the system parameters, download historic data logs, and monitor system performance. The additional front-panel interface also provides a simple means of system monitoring, and a convenient location for error diagnostics.

Installation Considerations

The AutoWaterManager is designed for installation on a ten-amp (or better) 120VAC circuit. Internally, the Manager maintains its own low-voltage power supply and uninterruptable-power-supply, documented further in a later section.

The AutoWaterManager is to be mounted by means of direct wall mount by two screw points. Additionally, ½-inch female conduit connectors are provided to support cabling. The Manager provides the latching mechanism to support a lock, and it is recommended that the Manager remain locked to prevent personal harm from high voltages that may be present during operation.

The AutoWaterManager utilizes a wiring block for convenient wiring application. The wiring of line power and relay contact outputs is documented at right in Figure 2.

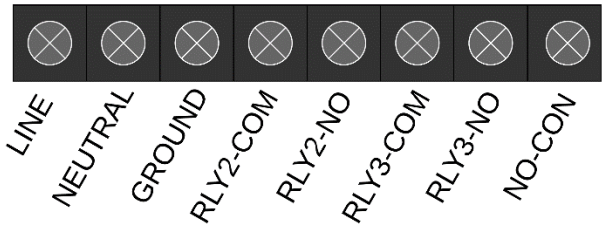

Figure 2 Wiring of the AutoWaterManager

Wireless Network Configuration

The AutoWaterManager utilizes two separate wireless network interfaces to support both its control and interactive interfaces. As shown in the figure below, the primary network interface is that which connects to the local area network for configuration, data transmission and additional user interfacing. The secondary network interface is that which connects to the supported control devices, i.e. the Wi-Fi enabled smart plugs responsible for switching the trough heaters on and off.

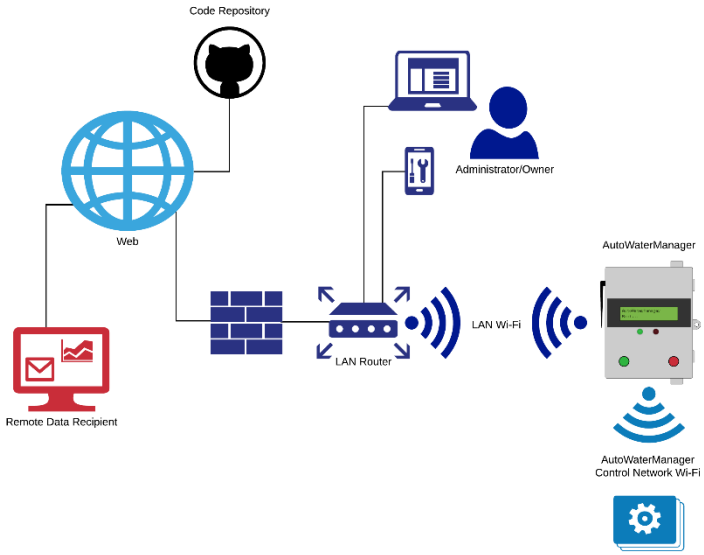

Figure 3 Wireless Topology for the AutoWaterManager

Wireless network settings can be configured by accessing the AutoWaterManager's wireless access point. The Manager's SSID is set to *BarnNet* by default with a password of *$t@nl3yt3ch*.

Using a Wi-Fi enabled device, and connecting to the AutoWaterManager's access point, a user can visit the wireless configuration web interface by navigating to *http://192.168.220.1:8080/RaspAP*. From this wireless configuration page, the local area network Wi-Fi parameters can be configured to allow the AutoWaterManager to communicate over the LAN, and provide access to the router, administrator configuration resources, and web services by means of the router and firewall.

The AutoWaterManager does not interface directly with remote web services for normal operation. Rather, the Manager interfaces with Google Email services and GitHub code repositories when generating and sending emails, or updating operating source code.

Front Panel

The front panel of the AutoWaterManager, though minimalistic, provides a breadth of available functionality, including enabling and disabling of temperature modeling systems, system rebooting, system shutdown and startup, IP address display, diagnostic error display, and generic status information.

Not Working? Try rebooting the AutoWaterManager by pressing both green and red buttons simultaneously.

During normal operation, the AutoWaterManager will display current date, time, and temperature information, updated every minute on the front LCD. Occasionally, the LCD can also display information related to errors, settings update notices, these additional messages are known referred to unscheduled messages and will only be displayed when triggered by the pertinent operation.

Although some additional buttons are made available internally for technical operators, there are three buttons exposed on the exterior of the AutoWaterManager. The two primary buttons are the red and green real-time-operational-control buttons on the front panel, the additional black button is mounted on the left side, directly below the wireless antenna. This side-mounted button is solely for turning the AutoWaterManager on, it serves no additional operational or control purpose. The green and red front panel buttons are multi-functional buttons that perform various operations as shown in the table above. Additionally, a quick command is supported to reboot the AutoWaterManager if both the green and red buttons are pressed simultaneously.

LENGTH OF PRESS	**Red Button**	**Green Button**
Quick (press and release)	Disable Modeling	Enable Modeling
Extended (> 3 seconds)		Display IP Address
Long (> 10 seconds)	Shut Down	Reboot

Table 1 Front Panel Button Operations

Web Interface

The AutoWaterManager provides access to configuration and monitoring through its web interface, a simple platform made available and supporting most common web browsers including Google Chrome, Firefox, and even the dreaded Internet Explorer. The interface supports two primary pages, and a small selection of additional unlinked pages, each of which is documented below.

PAGE	**Brief Description / Resources**	**Control / Configuration**	**Permissions Required**
/index */index.html*	• Main Web Interface • Status Overview • Live Data View • Historic Reports	• Barn Light (Relay Contact)	• None
/settings */settings.html*	• Settings Configuration	• Heater/Trough Parameters • Livestock (Animal) Names • Email Configuration	• None
/gitpull	• Repository Pull	• Source Code Update • Operating Service Restart	• Technician (Administrator)
/update */upgrade*	• Repository Pull • Firmware Update	• Source Code Update • Raspbian Dependency Update • System Reboot	• Technician (Administrator)
/delete	• Log Deletion	• Historic Log File Deletion	• Technician (Administrator)

Table 2 Available Web Interface Pages

Accessing the Web Interface

As mentioned earlier, the AutoWaterManager's web interface can be accessed with any modern web-browser including Chrome, Firefox, and IE. The web interface can be reached by accessing the AutoWaterManager's external network address, or the address of the wireless interface that is acting as a Wi-Fi client. The AutoWaterManager supports standard DHCP, and as such, will accept an IP address according to what the network router serves. This IP address can be found in several ways. By navigating to the DHCP serving network router's web interface and identifying the AutoWaterManager as a connected device is one method, but alternatively, the front panel of the AutoWaterManager can provide the current IP setting. It's also worthy of noting on some operating systems, or with some configurations, it is possible to simply navigate to *http://barnpi.local/* to access the AutoWaterManager's web interface.

On some operating systems, the AutoWaterManager can be accessed by the URL: "http://barnpi.local/"

'Index' Web-Page Overview

The index webpage is primarily just that. It is the main page of the web interface, and it provides real-time data, informatics, and system overview. There are no settings options available from the index page. The only control is that of the primary "Barn Light." This control is solely over one of the three relay contacts of the AutoWaterManager system, and it provides the ability to turn the relay on or off. The index also provides access to the historic log download for both the active log and the "previous period" log which captures the past thirty days-worth of data.

The AutoWaterManager index is grouped into several different primary regions as demonstrated below in Figure 3. The first region, boxed in the very top is the real time environmental information, displaying ambient temperature, battery status, presence of outdoor light, power source information and control status.

The second boxed region demonstrates the current heater status of each of the thirteen controlled heaters. Each heater can be shown in one of four states; heating (red container), cooling (blue container), disabled/out-of-service (grey 'X') system-failure/error (red '!').

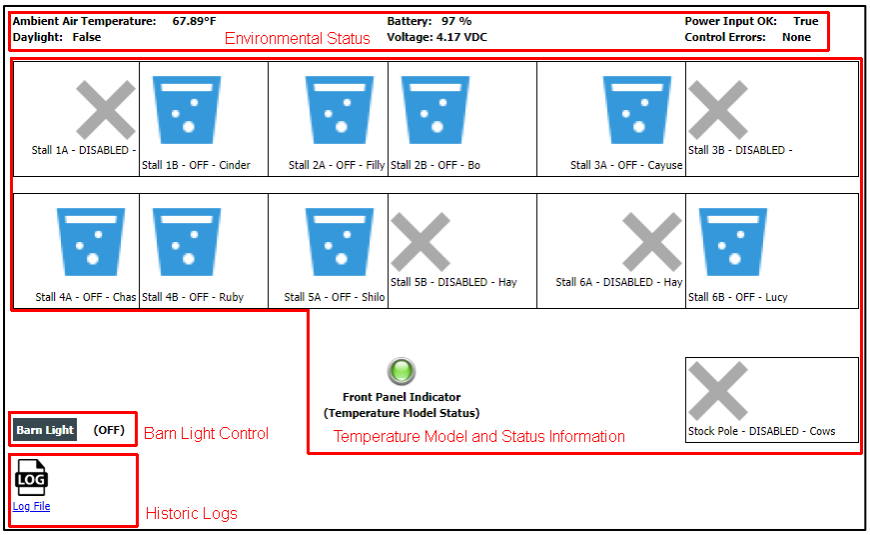

Figure 4 Web Interface 'Index' Overview

The third region of interest is the barn light control, boxed in the lower left-hand corner. This is merely a button that can be pressed to toggle the relay controlling the barn light. Additionally, the current status of the light is shown in parenthesis just next to the button.

The final region of interest is the historic logs section, where users can download one or both historic logs, in the figure shown, only the active log is available. If the previous period log were available, it would be shown right of the current image.

Figure 5 Web Interface 'Settings' Overview

'Settings' Web-Page Overview

The settings webpage primarily serves that purpose; a means of reviewing and configuring device settings. This page provides access to the primary settings configurations including the email configuration, message notification options, service configuration, and forceable heater control. Service states and heater control are explained in greater detail in the following section.

The first of these sections to address is the heater and trough parameters. These controls are important for the system operation as they directly impact system model performance, as such, they should be updated any time a change is made. Changes made to any settings require saving by means of the "Update General Settings button", or "Update Email Settings" buttons, respectively.

The AutoWaterManager supports up to three email addresses which are used when generating and sending automatic messages and alerts. Order and placement of addresses is not of significant importance. The options for which messages might be sent are configured in the section just to the right of the email addresses. Message purposes are described in Table 2, right. These message settings apply to all email addresses, as messages are sent in bulk to all addresses at once.

MESSAGE TYPE	Purpose / Application
Error Message	System error encountered, typically associated with a temperature-model related failure.
New Log Message	New log started after a thirty-day period, old log will be attached to message, total energy consumed, and average temperature evaluated and provided.
Settings Change Notice	New settings have been applied, full settings report provided in email body in tabular format, only sent when system settings change, not email settings.

Table 3 Message Types and Purposes

Service States and Forcing Heaters

Trough heaters may be placed in or out of service to effectively enable or disable their respective control. Heaters that are "in-service" are effectively enabled and actively controlled by the AutoWaterManager to maintain effective defrosting while maintaining high efficiency. By contrast, heaters that are "out-of-service" are effectively disable; permanently turned off until a time at which they are placed back in service. In order to maintain high efficiency, it is recommended that all unnecessary heaters are taken out of service to maximize system performance and energy savings.

Beyond the standard control functionality provided by service states, and the internally controlled nature of the AutoWaterManager's temperature modeling for each discrete heater, it may still be necessary to provide direct user input and force control of heaters. This functionality is provided by means of discrete heater force control. Individual heaters can be forced on or off for specific intervals of time (measured in hours) from the settings page of the AutoWaterManager web interface.

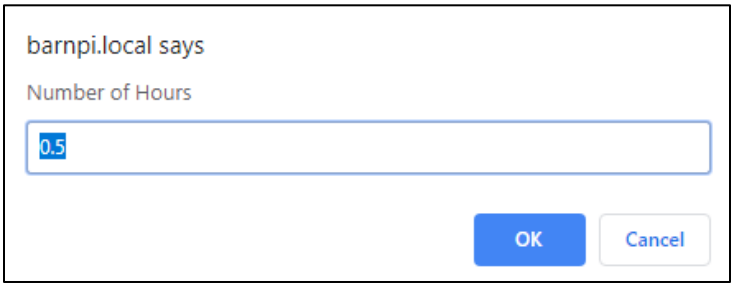

Figure 6 Force Time Input Window

Here, the image at left (Figure 3.) illustrates the standard popup message that the AutoWaterManager's web interface serves when a user requests to force the Manager to set a heater either on or off. By clicking either "Turn On" or "Turn Off" the AutoWaterManager will issue the popup request to determine the length of time (in hours) that the force (either On or Off) should be applied. By default, the AutoWaterManager provides a standard entry of 0.5 hours, or thirty minutes. Other fractional hour increments may be used, such increments include (but are not limited to) 0.25 for fifteen minutes, 0.083 for five minutes, and more.

Additional Web Pages

Though previously mentioned, the additional web pages are not intended for standard users, and as such, they will not be further documented. It is recommended that should such pages be required for any operations, the user should directly contact Stanley Solutions for further information.

API (Application Programming Interface)

All API calls interface through the standard web server and port with the URI extension: *"/api/status/<resource>"*

Like many modern Internet of Things (IoT) devices, the AutoWaterManager supports a standard Application Programming Interface. This API only supports GET-type HTTP requests, though plans for incorporation of POST functionality is desired in the future. All interaction with the interface is handled by the same web-server that feeds the primary web interface, so traffic competition may pose a problem if not handled correctly. To interact with the API, developers must leverage the URI extension: *"/api/status/<resource>."* Most status information is available through the API, and in addition, some control functionality is also made available and can be leveraged.

```
>>> from requests import get
>>> r = get("http://192.168.1.9/api/status/get_temp()")
>>> data = r.json()
>>> temp = data['get_temp()']
>>> temp
'69.69'
```

Figure 7 API Interfacing with Python

Demonstrated in the figure at right, simple API interfacing can be achieved with most commonplace programing languages, such as Python. Any language which supports web requests can interact with the AutoWaterManager's API. For more documentation on the available calls and operations, contact Stanley Solutions.

Temperature Model Considerations

The AutoWaterManager leverages an intelligent control and temperature modeling system that is capable of modeling each water-trough's temperature independently and based solely on the ambient temperature measured by the Manager. The temperature is measured by the thermal probe on the left-hand side of the AutoWaterManager, the temperature is used to evaluate the approximate temperature of each trough. The model calculates water temperature based on two primary functions, the cooling rate of water, and the heating rate based on heater coil power rating. At left is a figure demonstrating an evaluation test of the temperature model, operating on an assumed constant temperature of 31°F and a water trough size of fifteen gallons. The temperature model is, in fact, based upon the assumption that the trough size is fifteen gallons, this is because the water temperature constant is set at 0.00513, a value calculated by experiment for troughs of fifteen gallons. The cooling and heating rate calculation is shown in the equations below.

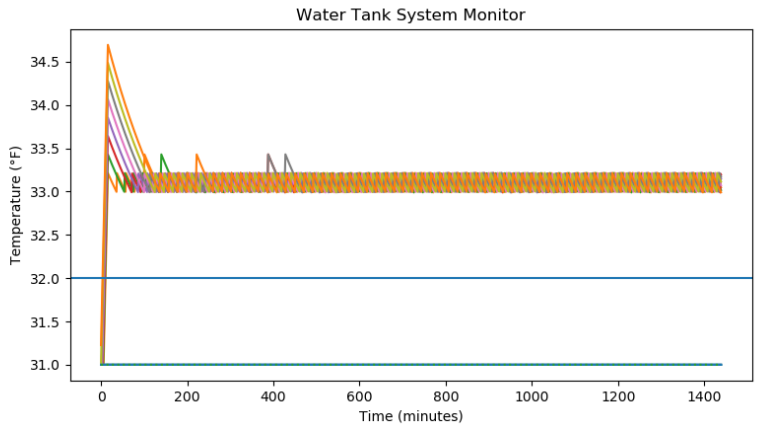

Figure 8 Temperature Modeling of Multiple Troughs by the AutoWaterManager

$$T_{\text{new (cooling)}} = T_{\text{ambient}} + (T_{\text{old}} - T_{\text{ambient}} \cdot e^{0.00513})$$

$$\Delta T_{\text{heating}} = T_{\text{old}} + \frac{60 \cdot 9 \cdot P_{\text{kW}}}{79.49361 \cdot V_{\text{gallons}}}$$

Specifications and Requirements

The following table provides general information about the AutoWaterManager's specified requirements, both electrical and mechanical.

PARAMETER	**Requirement / Specification**	**PARAMETER**	**Requirement / Specification**
Input Voltage	120 VAC RMS	*Trough Controls*	13
Control Voltage	5 VDC	*Wi-Fi Freq. Support*	2.4GHz
Rated Power	15 Watt	*Control Net. SSID*	BarnNet
Minimum Temperature	-10°F	*Control Net. Password*	$t@nl3yt3ch
Relay Current Rating	10A-250VAC / 5A-30VDC	*Control Net. Domain*	192.168.220.*
Breaker Rating	5A-120VAC	*UART Data Rate*	115200 BAUD

Table 4 System Specifications

Troubleshooting Tips

Should you run into any difficulties with the AutoWaterManager, there are several strategies to resolve potential issues. As with most electronic or computerized equipment, one of the best strategies is always to power-cycle the AutoWaterManager, which can be done in several ways. When still operating, but not performing at its peak, pressing both the red and green buttons on the front panel will restart the Manager, however, if the Manager is altogether unresponsive, rebooting may be performed by connecting via SSH and issuing a *"sudo reboot"* command. If an SSH connection is not an option, there are other options to shutdown the AutoWaterManager, but it is recommended that Stanley Solutions be contacted prior to such an attempt.

In general, the best way to address issues is to contact Stanley Solutions. Questions, comments, or requests may be addressed to Joe Stanley, owner of Stanley Solutions. Such questions or comments may be sent via one of the methods described below.

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Index