Opti Active Control Hardware Operations & Maintenance Manual

Prepared by

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mA Milliamp
NFPA National Fire Protection Association
OSHA Occupational Safety and Health Administration

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Safety Information

- Power must be turned off before servicing, modifying, or maintaining any equipment. Please refer to the de-energizing procedure.
- OptiRTC does not provide warranties for hardware beyond that of the vendor or manufacturer. It is the Owner's responsibility to verify hardware integrity prior to any on-site work.
- Only Qualified Personnel (according to OSHA 1910.332) should conduct electrical work on-site, and all work should conform to national and local electric codes (e.g. NFPA 70).
- Proper confined space entry procedures should be followed at all times when entering confined space outlet structures.

Contact Information

Contact Opti support or your designated Opti support engineer for online dashboard operation, site management, system operation questions, Opti services, and other support questions.

Email: support@optirtc.com
Phone: (844) 678-4782, Ext. 2

Necessary Tools

This is a list of tools routinely used for maintenance on Opti hardware.

- Panel key for unlocking the Opti Control Panel.
- Phillips Head screwdriver for opening panels.
- Small slotted 2.5mm screwdriver for changing screw and spring clamp terminal connections.
- Wire strippers and wire clips for installing sensors.
- Multimeter for checking connectivity and voltage. Be sure to understand multimeter use by using online tutorials from electronics websites such as iFixit and SparkFun.
- Soft cloth for cleaning solar panels.
- Bucket for calibrating water level sensors.
- Water depth gage for calibrating water level sensors.

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Introduction

This manual provides guidance for operating and maintaining the hardware for your Opti installation. Opti's active control technology integrates cloud-based software, sensors and flow or volume controls in the field, with the weather forecast to reduce flooding, improve water quality, control combined sewer wet weather flow, and/or restore ecological flow rates in streams.

Each Opti installation is unique and may include hardware not described in this manual. Contact Opti Support for questions about custom hardware maintenance.

Figure 1: Opti active control installation

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Hardware Information

The basic Opti active control configuration includes a power source, a control panel, a water level sensor, and a continuous actuator controlling a butterfly valve. Many Opti installations have site-specific hardware, including other sensors and other types of valves. Refer to site drawings for information on your hardware installation and component locations.

Opti Control Panel

To open the Opti Control Panel, unlock the lock on the panel. Depending on the type of panel, you may need to unlatch latches on the side, turn knobs, or use a large flathead screwdriver to access the swing door and the interior (Figure 2). As a security feature, Opti logs when the panel is accessed by sensing when the door is open or closed. Be sure to close and lock the panel after all on-site maintenance.

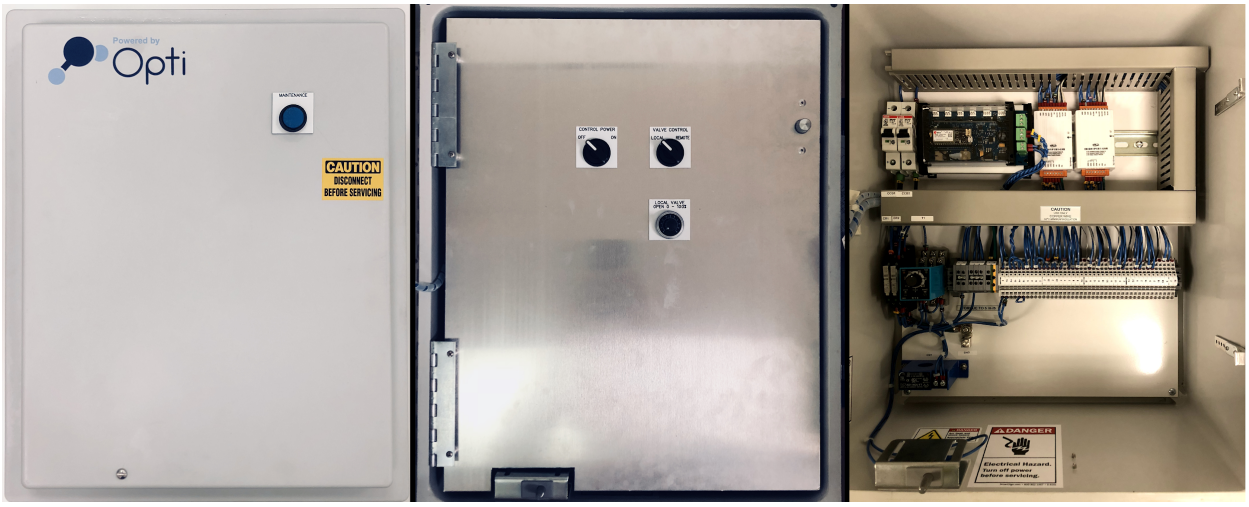

Figure 2: Opti Control Panel cover, swing door, and interior (left to right).

Swing Door

The control panel swing door is shown in Figure 3. The swing door has three switches for cycling power to the control panel, setting manual or remote control, and setting the valve position if the site is in manual mode. Note that the control power switch does not act as a circuit breaker.

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Figure 3: Opti Control Panel swing door controls

Control Panel Interior

An example control panel is shown in Figure 4. While there may be wiring differences between this example panel and the panel for your site, this image can guide you around the various parts that may be included in your panel. Before electrical maintenance, check the wiring and electrical diagrams prepared for your site.

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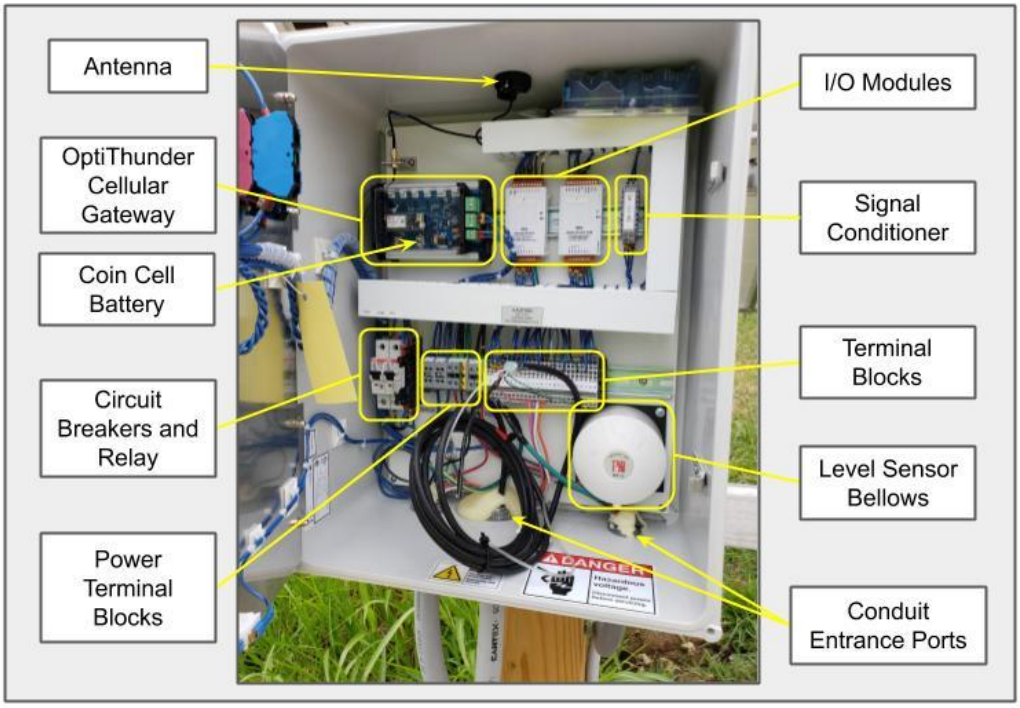

Figure 4: Opti control panel annotated with major components

OptiThunder Cellular Gateway

All electrical components in the control panel are controlled by the OptiThunder cellular gateway. OptiThunder is Opti's proprietary cellular gateway, which connects the panel to the Opti cloud platform. The OptiThunder cellular gateway receives, processes, and sends commands to and from all sources, and maintains failsafe behavior during long offline periods.

OptiThunder Indicator Lights

The OptiThunder cellular gateway processes all incoming sensor and battery information and connects the panel to the Opti cloud platform. When on site, the status indicator lights will provide the best indication of its behavior. During normal operation, the status light "breathes" cyan by fading in and out softly. Cycling power to the control panel will turn the OptiThunder cellular gateway off and on, and its indicator lights will provide information about its status as it changes (Table 1). There may also be a second, smaller LED that blinks red, which can be ignored.

If the OptiThunder cellular gateway is unable to establish a cloud connection after 5 minutes, power cycle the control panel using its circuit breaker to force OptiThunder to reconnect. If the issue persists contact Opti support staff for further assistance.

Table 1: Common status indicator light signals

LED Color/Behavior	Explanation
Flashing Green	Connecting to cellular network
Flashing Cyan	Connecting to cloud
Breathing Cyan	Successfully connected to cloud
Blinking Blue	Check SIM card connection

I/O Modules

The I/O modules are used to manage signal inputs and outputs by converting sensor data signals to and from their various protocols. The OptiThunder cellular gateway communicates with the RS485 modbus communication protocol, and the I/O modules convert those signals to and from 4-20 mA and other sensor data signals.

Panel Circuit Breakers

Circuit breakers are labeled CB1 and CB2. When performing electrical maintenance, make sure both circuit breakers are turned off. CB1 controls power to the panel and CB2 controls power to the actuator.

Relay

The relay manages timed connections, and cycles power off and on to hardware which is powered on regular intervals.

Signal Conditioner

The signal conditioner manages the input signals from the manual controls on the swing door. It converts those inputs into 4-20 mA signals before they are read by the I/O modules. Typically, this is used to open and close the valve from the panel, bypassing Opti's online controls.

Terminal Blocks

Opti uses both screw terminals and spring clamp terminals. To insert or remove wiring to a screw terminal, simply loosen the screw to make changes and tighten the screw after inserting a wire. To insert or remove wiring to a spring clamp terminal, insert a thin, flathead screwdriver into the square hole next to the circular wire terminal. Push the spring clamp outward to open the terminal and insert or remove the wire. After inserting wires, make sure the connection is strong by gently tugging the wire.

Power Terminal Blocks

The power terminal blocks are standard terminal blocks that are rated for higher voltage and current loads. Connections at these terminals send power to all panel components.

DIN Rail

The DIN rail is a standard mounting bracket which many components can clip onto. To disconnect a component from the DIN rail, pull out on the component's mounting clip on the bottom rail, and gently lift it off the rail.

Panel Ground

The panel is electrically grounded at the panel ground to prevent dangerous voltage levels from building up if the panel is electrically damaged.

Level Sensor Bellows

The level sensor bellows, or pressure reference device, keeps moisture from entering the level sensor's vent tube. This allows the level sensor to reference atmospheric pressure, assisting with the measurements' calibration.

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Valve and Actuator

To control the valve position, the control panel sends power and a 4-20mA signal to an actuator. The actuator then applies torque to the valve to open or close it, and sends a signal back to confirm the position of the valve. During installation, maintenance, or system failure, the valve can be controlled by a human operator. Additional data available for the actuator (added to dashboard by request) includes indicators from the valve manufacturer of potential motion inhibition, valve jammed, or valve obstructed. See the Valve Override Operation Procedures for more information.

Figure 5: Example of actuator with manual hand-crank (left) and butterfly valve (right)

Water Level Sensor

Water level sensors are used as feedback to adapt to changing site conditions. Water level is detected with a pressure transducer which converts pressure into an electrical signal. To minimize error from waves and other disturbances, the pressure transducer is protected in a stilling well.

Power

Opti hardware can be powered by 120 V AC line power or a 24 V DC battery charged by a solar panel. If line powered, there will be a breaker nearby to disconnect power. If power is lost, a power backup battery will move the valve to a predetermined failsafe position. If the site is solar powered, the batteries will provide this failsafe functionality. Batteries on solar-powered panels are rated for ten days of autonomy on a full charge. However, the

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battery will lose charging capacity over time if not connected to the solar power source for longer than 6 months.

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Maintenance Procedures

This section describes operation and maintenance procedures for Opti hardware. In addition to corrective maintenance, all components should be inspected for signs of wear or damage during every site visit or as needed based on site-specific conditions. Refer to Appendix A for an inspection and maintenance log with suggested routine maintenance procedures.

Routine Maintenance

Site and system component inspection should follow the procedures outlined below, as well as inspection for wear, vandalism, corrosion, or other damage (Table 2). Refer to the manual for each hardware component (provided as separate attachments) for a more complete description of maintenance.

Table 2: Recommended routine maintenance procedures

Component	Maintenance Procedure	Recommended Frequency
Opti Control Panel	Winterize and dewinterize if needed. Cycle power and replace components if needed.	Annually
Coin Cell Battery	Replace coin cell battery on OptiThunder Battery type: CR1220s	Annually
Solar Power Kit	Clean solar panels with a soft cloth. Check battery charge. Both batteries should have the same charge.	Biannually
Water Level Sensor	Winterize and dewinterize if needed. Visually inspect for obstructions and fouling. Calibrate any time the sensor moves. Check calibration during every site visit. Inspect junction boxes for water damage.	Biannually and during every site visit
Rain Gage	Inspect for debris, obstructions, and corrosion.	Biannually and during every site visit
Actuator	Clean as needed. Confirm valve calibration. Test battery backup failsafe position.	Biannually and as needed based on email alerts

Valve	Inspect for debris and obstructions. Clean as needed.	Biannually and as needed based on email alerts
Gate	Inspect gate and stem for misalignment or damage. Check lubrication, apply lubrication if necessary. Clean stem using brush with stainless steel or brass bristles. Do not use steel bristles or hand grinders. Check for bronze dust or shavings. Replace lift nuts if dust or shavings are found.	Biannually or more depending on use frequency and as needed based on email alerts
Trash Rack and Stilling Well	Inspect for debris and obstructions. Clean as needed. Draw down pond if trash rack is submerged.	Biannually and during every site visit

Control Panel De-Energizing Procedure

Whenever maintenance is required, the control panel and components must first be de-energized. The steps below outline the de-energizing procedure:

1. Unlock the control panel enclosure and access the swing panel.
2. Turn the Control Power switch to the off position.
3. Open the swing panel. Locate the panel circuit breakers, labeled CB1 and CB2, and turn them down to the off position.

All connected devices are now de-energized and maintenance can proceed. Note that this does not de-energize the input energy source in the site's solar kit or line power connection.

Valve Override Procedures

There are three procedures to override the valve controls, which ensure reliability during software, connection, hardware, or power failures: online, control panel, and manual override. Generally, online override can be used for remote maintenance while the control panel override is used when on site. During a cellular connection failure, the control panel override can be used. During power failure, the valve can be controlled with a manual override.

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Remote Manual Control

A user with administrative permissions can override the Opti automatic controls of the valve using the online dashboard. Sign into the Opti web portal and navigate to the system control pod in the top left (Figure 6).

1. Change the Operation Mode to Manual Control. Confirm this change with the "Change" button.
2. Enter the desired percent open. Confirm this change with the "Commit" button.
3. When finished manually controlling the valve, set the operation mode back to Automatic Control and confirm with the "Change" button.

Please note that Opti's security features prevent users from making more than one command per four minutes over an online connection. Your commands will take four minutes each to process. An additional rate-limiting security feature prevents the valve from opening fully faster than 20 minutes. It is able to close instantly (as long as it has been four minutes since the most recent command).

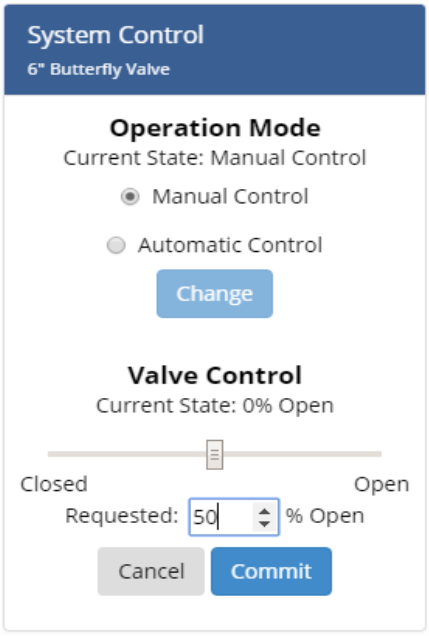


Figure 6: System Control pod

Local Manual Override with Control Panel

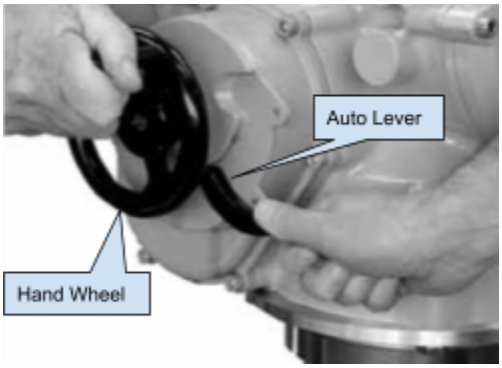
When on site, remote control can be overridden with the following procedure:

1. Locate the switch and knob on the swing door labeled “valve control” and “local valve open” (Figure 3).
2. Make sure the “local valve open” knob is set to the desired open percentage.
3. With the system powered on, turn the “valve control” switch to the local position. To make any further changes in local mode, turn the “local valve open” knob to the desired percentage open.
4. Once maintenance is complete, set the “local valve open” knob back to 0% open and turn the “valve control” switch to the remote position, so that Opti can continue to autonomously control the hardware.

Local Manual Override with Hand Crank

To physically operate the valve using the hand crank, follow this procedure:

1. Follow the Control Panel De-Energizing Procedure to turn power off.
2. Turn the handle on the actuator until the butterfly valve is at the desired set point. The valve position is reported on the screen of the actuator. To engage handwheel drive, turn the Hand/Auto lever clockwise while turning the handwheel. The lever can now be released upon which it will return to its original position. The handwheel will remain engaged until the actuator is operated electrically when it will automatically disengage and return to motor drive.



Actuator Calibration

To check the calibration of the actuated valve, follow this procedure:

1. Use remote manual control to place the valve into the fully open position. Once the valve is fully open, record the time.
2. Command the valve to 50% open. When the valve stops moving, record the time. Note that the valve will be at an angle greater than 45°, since we are calculating percent area open.
3. Put the valve in the fully closed position (0% open). When you can see the valve is fully closed, record the time.
4. Contact Opti Support and send the three recordings of time and target positions.

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Battery Back-up Failsafe Position Confirmation

The battery back-up failsafe position needs to be confirmed during routine site visits. To test this, de-energize the control panel using the process described above. Record the position of the valve (usually either fully closed or fully open) and report this position to Opti Support.

Water Level Sensor Calibration

Water level sensors may need to be calibrated after: installation, dewinterization, re-location of sensors, or when data shown on the dashboard does not match observed values. All calibration is done through Opti software and requires no hardware changes. To take calibration measurements, follow this procedure:

1. Place the water level sensor in a bucket of water.
2. De-energize the Opti Panel using the power switch.
3. Measure the depth of the sensing element at the end of the pressure transducer.
4. Turn the Opti Panel back on and wait until the status indicator light breathes cyan. This indicates that a pressure is being recorded and sent to Opti. Record both the time of the measurement and the depth of water.
5. Place the water level sensor in its final position in the body of water, and repeat steps 2-4 to record the sensor depth and time. Do not move the sensor afterwards.
6. Measure the distance between the water surface elevation and a known elevation such as a valve elevation, and record the time.
7. Contact Opti Support and send the three pairs of time and elevation measurements.

Winterization and Dewinterization

Winterization may be necessary if a site encounters freezing temperatures during winter months. Winterization is done to avoid damage to sensors caused by expansion of freezing water. Sites may not need winterization if sensors are installed deep enough where water does not freeze. A typical winterization and dewinterization process follows the steps below.

Winterization

1. Follow the control panel valve override procedure and place the valve in your site's failsafe position using the valve open percentage dial while in local control mode.
2. Remove the sensor from the water and store it at an elevation where it will not be submerged. The sensor(s) may be attached with zip ties, with any extra cable looped

neatly. This is recommended for pressure transducers, TSS sensors, and multiparameter sensors, which may be damaged by freezing water.
3. Once you have locked the site again, notify Opti support via email or phone that the site has been winterized.

Dewinterization

1. Replace all sensors in their original location in the water.
2. Follow the procedure described in Water Level Sensor Calibration by recording two water level sensor depths and times, and a reference elevation.
3. Notify Opti Support that the site is now dewinterized. Include water level sensor calibration measurements.
4. Place the site from manual mode into auto mode.
5. Monitor the site for one week or until the first rain event to ensure it is functioning correctly.

Coin Cell Battery Replacement

The coin cell battery on the OptiThunder cellular gateway helps preserve information about the device's state and configuration during power outages to the device. We recommend replacing it once a year. Available at Home Depot or similar. See example at right.

In order to replace the battery, remove the plastic cover over the OptiThunder by pulling directly away from the device. The coin cell is located in the bottom-right corner. Carefully remove the existing battery and replace it with the new one. Ensure it is replaced in the same orientation (+ side facing out).

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Troubleshooting

Troubleshooting involves identifying an issue and performing corrective maintenance on an unknown problem. Troubleshooting becomes much easier with a good understanding of dependencies within the Opti active control system and the correct tools to detect where failures may be occurring.

Dependency Flow Diagram

The diagram shown in Figure 7 is a simplified view of the flow of information and power through various components. An arrow indicates a direct dependency, in which information or power may flow between components. This diagram can be used to help find, diagnose, and repair problems either remotely or on site.

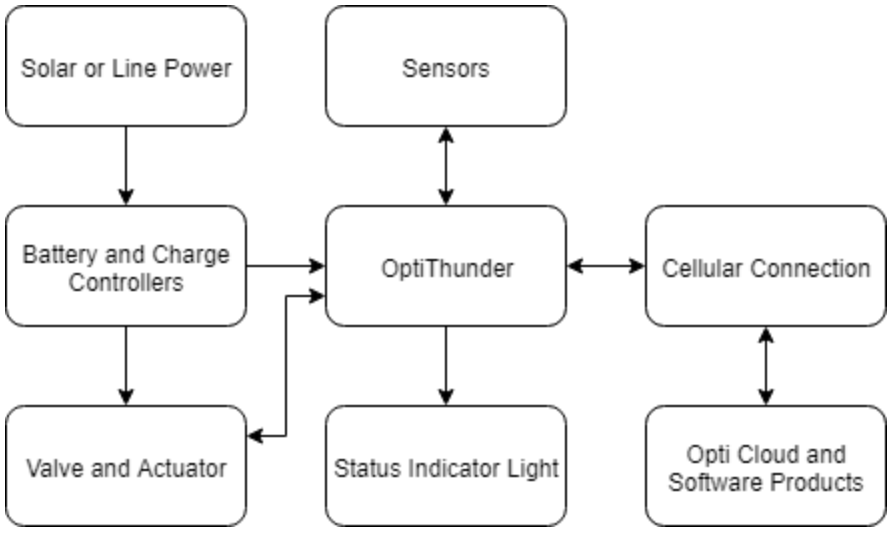

Figure 7: Dependency flow diagram

Triggers for Maintenance

By providing real-time data online on the Opti Dashboard, indicators of maintenance needs can be observed remotely. Please see below for some examples of unusual data patterns (observed on the Opti Dashboard) that indicate when maintenance is required: Valve Clog, Pressure Transducer Electrical Failure, and I/O Module Disconnection.

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Opti Dashboard Troubleshooting Examples

Valve clog

In this example, a valve was stuck at approximately 18% open and would not follow any further valve commands (Figure 8). This was caused by a clog which prevented the valve (blue) from opening to its target state. The valve flatlined, and didn't respond to further commands. Once it was placed in online override mode and opened further, the valve opened and the clog was released. It was immediately returned to automatic mode and showed normal behavior during a drawdown period the next day.

If a valve's percentage open is more than 5% different from its target state, this is often due to a clog preventing further valve movement. Clogs are often resolved by placing the valve in manual mode and sending commands to fully open and close. These commands will send a larger amount of torque to the valve and likely clear any present clogs. If the issue persists, go on site and perform a Control Panel Override on site to clear the clog. If problems persist, contact Opti Support to help determine the cause.

Figure 8: Opti dashboard during a valve clog

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Pressure Transducer Electrical Failure

In this example, the water level sensor PT3 (orange) frequently spikes to the high end of its range (Figure 9). Since the sensor outputs an electrical signal, it appears that electrical components may be short-circuited. This sensor shows this behavior intermittently and may be irreparably damaged. To troubleshoot water level sensor issues, follow routine maintenance procedures by checking all connections to the sensor, cleaning dirt and debris, and checking the desiccant. If the problem continues, replace the sensor.

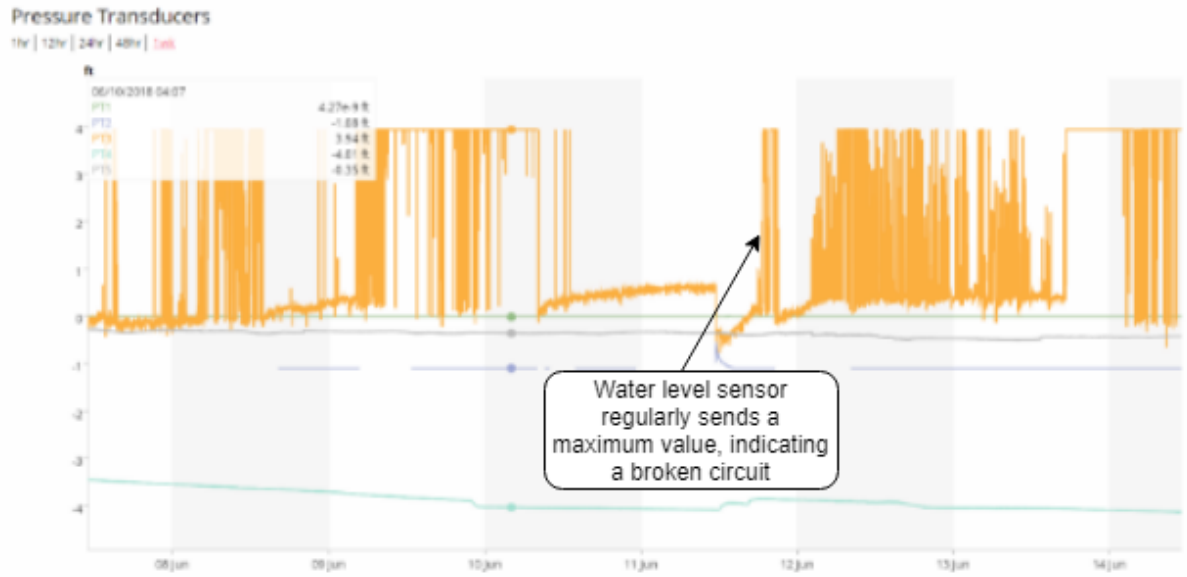

Figure 9: Faulty pressure transducer readings

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I/O Module disconnection

In this example, all of one site's pressure transducers showed a loss of connection at the same time on August 10 (Figure 10). However, the internet connection remained online. This failure happened due to a disconnection from one of the I/O modules. Since the wire terminal on one side of the I/O module does not screw in to protect it from coming loose, it may disconnect if the wiring is too tight and pulls it away. Wiring may disconnect across many panel components; to ensure reliable wiring, gently tug all wire and terminal connections when installing and changing connections.

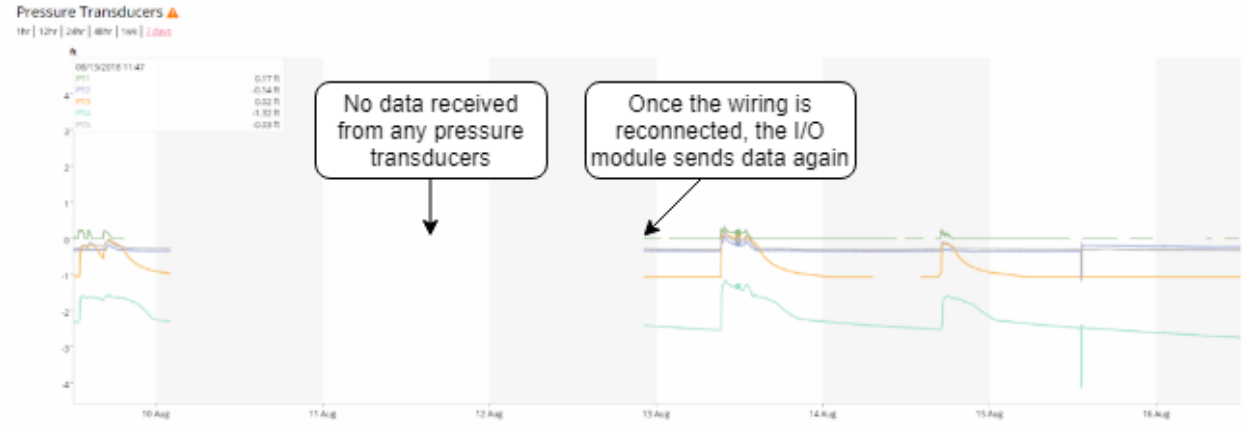

Figure 10: Sensor datastream failure during I/O module disconnection

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Appendix A: Inspection/Maintenance Log

Personnel:	
Date and Time:	
Weather:	

Water Level Sensor

Checklist Item	Result
Winterization / dewinterization?	
Clean sensor and stilling well	
Water level measurement	Water level (in): Time of measurement: Reference datum description:
Pressure test (if available)	Measurement 1 - Pressure: Measurement 1 - Date / Time: Measurement 2 - Pressure: Measurement 2 - Date / Time:
Junction box watertight / dry?	Y / N
Bellows dry?	Y / N

Comments / Notes:

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Control Panel

Checklist Item	Result
Inspect interior of Opti Control Panel for water intrusion or pest infestation	
Inspect all exposed conduit for damage or loose connections. Repair if necessary.	
Replace OptiThunder coin cell battery. Battery type: CR1220s (found at Home Depot). Example: 	
Inspect rain gauge for debris, obstructions, and corrosion. Clear debris and obstructions as needed.	

Comments / Notes:

Valve / Actuator

Checklist Item	Result
Clear trash rack of debris	
Calibration check: Set to 0% and 100% open from Opti Panel	Valve closed position (from screen): Valve open position (from screen):
If line power: Cut power to actuator (battery backup testing)	Valve position:

Comments / Notes:

Solar Kit (if applicable):

Checklist Item	Result
Wipe solar panels with cotton cloth	
Check battery charge with multimeter (should be equal)	Battery 1 Voltage: Battery 2 Voltage:
Remove any vegetation directly blocking solar panel	

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Completed By: _____ Signature:_____Date:_____

If actuator is for a gate, replace valve / actuator with the following:

Gate / Actuator

Checklist Item	Result
Clear trash rack of debris	
Calibration check: Set to 0% and 100% open from Opti Panel	Valve closed position (from screen): Valve open position (from screen):
If line power: Cut power to actuator (battery backup testing)	Valve position:
Inspect gate stem (If yes on any, contact support@optirtc.com)	Signs of misalignment? Y / N Bronze dust / shavings? Y / N Signs of damage? Y / N
Lubricate valve stem	
Clean valve stem (**DO NOT USE** steel bristles or hand grinder)	

Comments / Notes:
