AQUATRAC™
INSTRUMENTS, INC.
SYSTEM DESIGN & ENGINEERING

AEGIS

Water Treatment Controller

Technical Manual

Contents

Safety Electrical Shock Hazard

Opening the controller enclosure with the controller plugged in, exposes the user to AC line voltages on the backmost of the two controller circuit boards.

Ground the controller AC power to the ground screw labeled and located on the bottom, right of the aluminum backplate.

External, 120VAC socket or optional plug boxes are provided with controllers installed in North America. Both are grounded to the ground screw labeled located on the bottom, center of the aluminum backplate.

USER WARNING : CAUTION

Water Treatment Controllers operate steam and water valves and may pump hazardous, corrosive and toxic chemicals. Opening the controller enclosure exposes user to the risk of electrical shock at power line voltages.

Understand fully the implications of the control setpoints, interlocks and alarms that you select. Harm to personnel and damage to equipment may result from mis-application.

Unplug or turn OFF the AC power to the controller if you have any concerns regarding safety or incorrect controller operation and notify supervisory staff.

YOUR CONTROLLER

AEGIS Controllers are supplied in many different configurations, part numbers and sensor sets. Applications extend beyond water treatment.

The **HELP** section available in the Aegis_User manual, depicts the installation plumbing header showing the sensor set supplied with your controller. It also includes the information for terminating the sensors supplied with your specific controller part number.

The **START-UP** section available in the Aegis_User manual, is specific to your application and details modifying the default controller settings for your site.

1. Overview

1.1 Applications

Aegis controllers are optimized for water treatment applications. These controllers measure the sensors used to control water treatment chemical feed pumps, blowdown valves and bleed solenoids.

The control methods used to do both conventional and complex water treatment are built-in.
Sensor sets are easily modified post-purchase to meet changing site needs.
ON-OFF, AC powered pumps and solenoids may be mixed with frequency controlled pumps.

Aegis controllers do a lot more than the summary information in the following table:

Application	Measures	Controls
Cooling Towers	Tower Conductivity Make-up Conductivity pH ORP Corrosion Rate Make-up Volume Gray water make-up Bleed Volume Water Temperature Flowswitch Tank level switches Chemical fed volume	Bleed on tower conductivity, on cycles of concentration, on ratio of make-up to bleed volume…. Feed Inhibitor on ppm setpoints, based on bleed, proportional to make-up, base feed…. Feed pH correction acid ON/OFF, proportionately, by make-up volume… Control both acid & caustic. Feed bleach on ORP using a pot feeder, or proportional. Base feed bleach and shock during biocide feed events. Sum or difference water meters to feed inhibitor. Prebleed and Lockout biocide feeds. Block some chemical feed while others feed. Feed on corrosion rate, temperature….. Calculate ppm based on volume fed & cycles of concentration.
Boilers	Boiler Conductivity for 1 to 3 boilers. Condensate Conductivity Feed water volume for each boiler Steam demand Condensate pH Day tank levels. Verify feed	Captured sample & continuous blowdown controls. Feed treatment based on each boiler make-up & meter amine based on the sum of make-ups or the steam demand. Feed sulfite on temperature or base feed. Operate condensate bypass valves. Log, monitor and control on hardness analyzers. Log and an alarm on condensate pH. Average pH to control time lagged condensate pH. Mix & blend day tanks.
Waste Water	ORP, pH Make-up and drain volumes and rates. Tank high & low levels. Conductivity	Hold & mix to hit target, conductivity, pH, ORP, temperature prior to drain. Feed flocculants on volume, turbidity… Sequence feeds, mixing and discharge. Alarm on fail to feed.
Process	Conductivity-Resistivity Corrosion Rate Up to 4 pHs or ORPs Rates as 4-20mA Any mix of water meters and contact sets not exceeding 8	Feed or control based on ON/OFF setpoints, volume measured, volume fed, time of day, day of week, base feed. Alarm on runtime or volume fed or high or low sensor levels. Delay on alarm to avoid transient states alarming. Sequence on contact sets. Invert the logical sense of contact sets. Ratio sensors and volumes. Meter on volume fed.

1.2 Sensor Inputs & Control Outputs

Users can change the default names of sensors, pumps and valves to meaningful, site specific names.
For example, although you may name controller meter input '**P**' to 'City Make-up', '**P**' identifies where the meter is connected and the letter '**P**' is used to represent the 'City Make-up' input in controls and data logging.

The controller uses the letters '**A**' thru '**Z**' to identify sensor, water meter, flowswitch and contact set inputs and the numbers **1** to **9** to identify AC power switching relays and frequency outputs.

'**A**' to '**G**' and '**O**' to '**V**' exist as terminal blocks where inputs are connected. Sensor inputs '**H**' to '**N**' and meter/contact set inputs '**W**' to '**Z**' are used to implement more complex control and monitoring functions.

Any input may be used to control any output or outputs.

I/O Point	Function	Notes
Sensor **A**	Fixed conductivity sensor drive	Support for both cooling tower and boiler-condensate sensors. Most controllers have at least one conductivity sensor.
Sensor **B**	Fixed thermal sensor drive	Support for the 10mV/K and CTF type temperature sensors, Thermal compensation for the 'A' conductivity or stand-alone feedwater thermal sensor
Sensors **C-D** and **E-F**	Two sensor card slots. Each slot can take a single or dual sensor driver card	Plug & Play sensor cards auto-reconfigure the controller when the card is installed. Available Card set: Conductivity-Temperature, Single & Dual Boiler Conductivity, Single & Dual pH-ORP, pH-Temperature, Single & Dual Corrosion Rate, Dual 4-20mA input. Single & Dual 4-20mA output.
Sensor **G**	Fixed 4-20mA input	Support for loop powered and isolated 4-20mA levels on Chlorine or ClO2 or feed rate or turbidity…
Sensors **H** to **N**	Phantom sensor inputs used for control and logging.	Inputs used to for calculated and manually entered values: Calculated ppm & inventory-tank levels. Manually entered drop count-chemical test results…
Meter-Contacts **O** to **V**	Eight digital inputs, individually configurable as meter-volume or contact set inputs	Meter-volume inputs totalize, display volume today and this year, calculate turbine 'K' factors and debounce contact head meters. Contact sets are flow and level switches. They are used to interlock and to initiate feeds.
Meter-Contacts **W** to **Z**	Phantom digital inputs used for control and logging.	A 4-20 GPM input may be converted to a volume @ 'X' A relay state may be 'mirrored' by phantom input 'Y' which is used to start a rinse sequence by controlling relay No.4
Relays **1** to **5**	AC Line powered ON/OFF controls	Controller powered outputs switch 120 or 230VAC pumps, valves & solenoids ON/OFF. Log time ON. Alarm on runtime per actuation & per day. Relays 2-5 are SPDT for motorized valves requiring power OPEN & power CLOSE.
Frequency Outputs **6** to **9**	DC isolated, non-mechanical 0 to 400Hz	Variable speed feeds, with presets for popular pump ml/stroke and maximum rate. Calculates & logs volume fed. Use volume fed to calculate ppm & inventory.

1.3 Communications

1.3.1 USB Services

All Aegis controllers include a USB port which is used for three purposes:

1. Upload of logged data in XML format to a notebook PC or a PDA operating as a USB host.
2. Download of View-Configuration Sets into the AEGIS.
3. Upload of the current controller configuration from the AEGIS to support generation of View-Configuration Sets and for controller cloning.

1.3.2 Configuration-View sets:

Controllers with the '**LB**' Ethernet option are loaded with from 1 to 15 View-Configurations. One of these is selected when the controller is manufactured to be the 'as shipped' view-configuration.

Installed View-Configurations represent possible, future uses of the controller.
For example ORP and/or make-up conductivity sensors and controls are routinely added to installed controllers. Configuration and Views are preloaded to support these upgrades.

1.3.3 LAN TCP-IP:

The **LB** controller option adds a 10 Base T, RJ45 Ethernet port with a user assigned static IP. The controller operates as an HTML micro-server for command & control using IE7 and Mozilla's Firefox browsers.
Logged data is served as an XML file in response to an HTML request.

1.3.3 Modem:

The **RM** controller option adds a 57,600 baud micro modem that provides a PPP connection so that remote users can browse the controller. AJAX supports the same graphical View interface used by on-site users.

1.4 Field Upgrades

Sensor driver cards can be added after installation by powering OFF the controller, plugging in the upgrade card and powering ON. The controller recognizes the new hardware and auto-configures, modifying the LCD display to add the new sensor inputs and sub-menus. The diagnostic browser view auto-enables the new sensors and displays their current values.

No additional hardware is required to connect another water meter, flow or level switch. Enable the input and the new device appears automatically in all of the selection and configuration menus.

1.5 Data Logging

Each enabled input and output is logged by the controller as a user set interval from 5 to 1440 minutes. Each I/O can be independently logged at its own rate. The default rate for all I/O is 60 minutes with a 600 sample log size. Sensors log minimum, maximum and average. Water meters log volume. Contact sets log time ON.
Power Relays controlling pumps and valves, log ON time in seconds.
Frequency controlled pumps log volume pumped in mL in each log period..

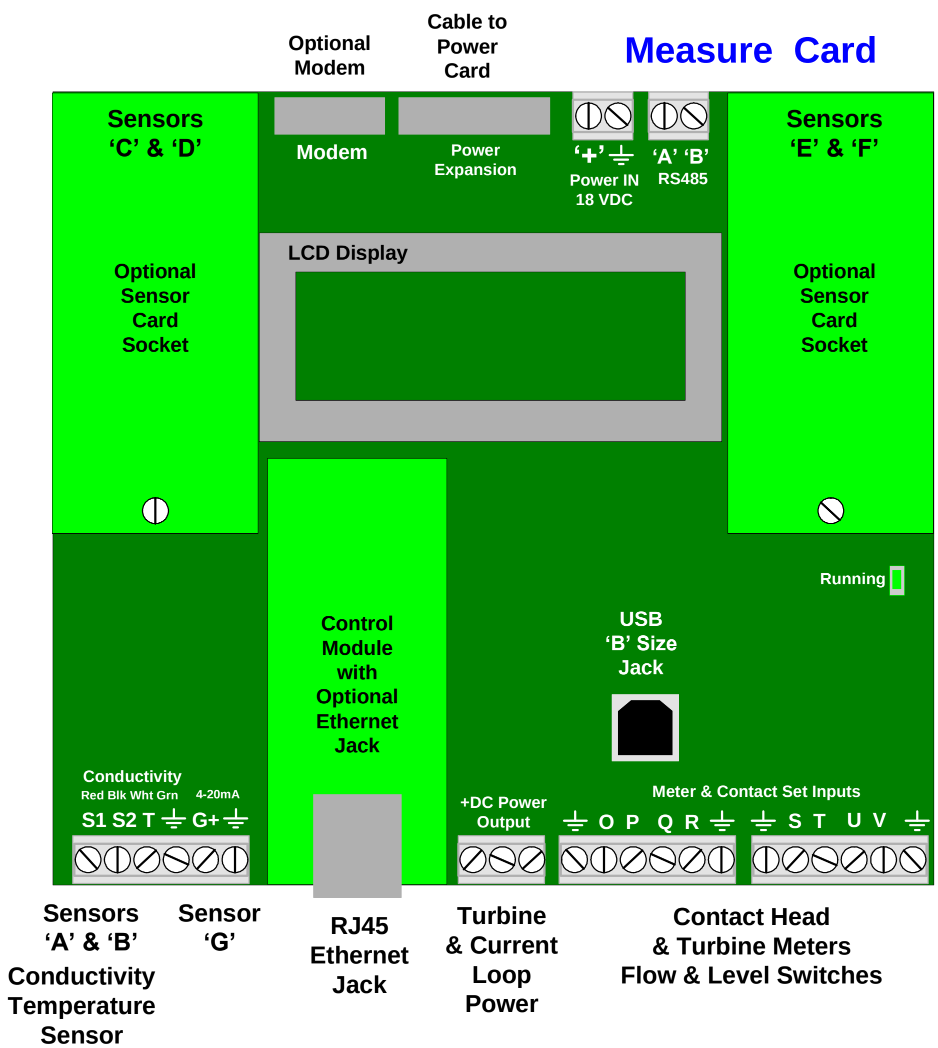
Alarms are time & date stamped. The last 25 controller activities are time and date stamped with the user ID.
Note: Data logging of relay ON time stops when AC fuse fails since without a fuse a relay
can't power ON a pump, valve or solenoid**.**

2. Installation-Commissioning

2.1 Cabling – Wiring

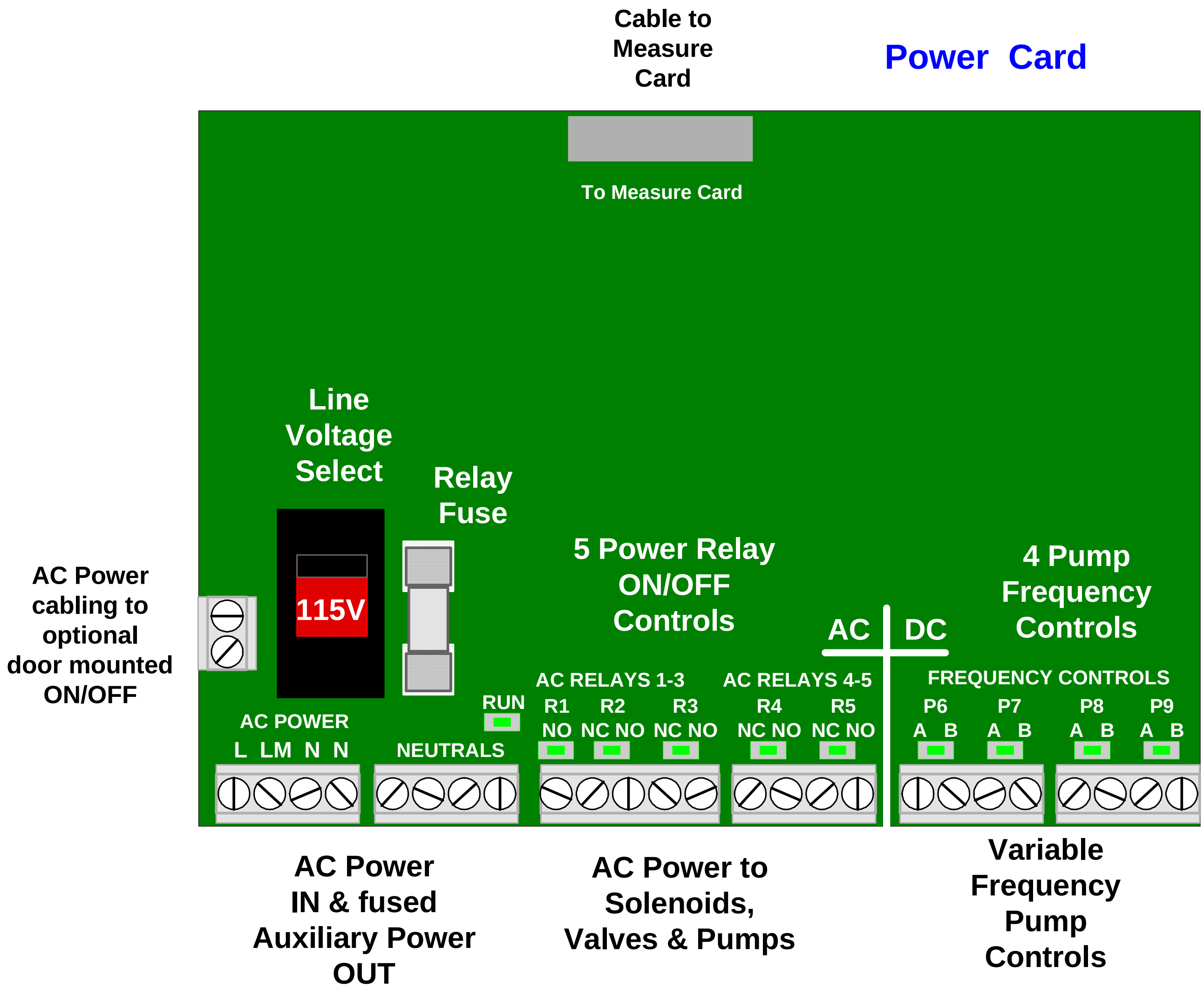
2.1.1 Controller Wiring Terminals

Controllers consist of two circuit boards, a front **Measure** circuit board and a back **Power** board.
The front, **Measure** circuit board supports 7 sensor inputs & 8 digital Inputs.
It includes a 2 line x 16 character LCD display, USB Type 'B' jack and a microcontroller module.



2.1.1 Controller Wiring Terminals cont.

The back, **Power** circuit board has 5 ON/OFF Power Relays, 4 Variable Frequency Feed outputs and the controller power supply.
The **Ai**, industrial version of the Aegis, includes an enclosure door mounted AC Power ON/OFF switch.

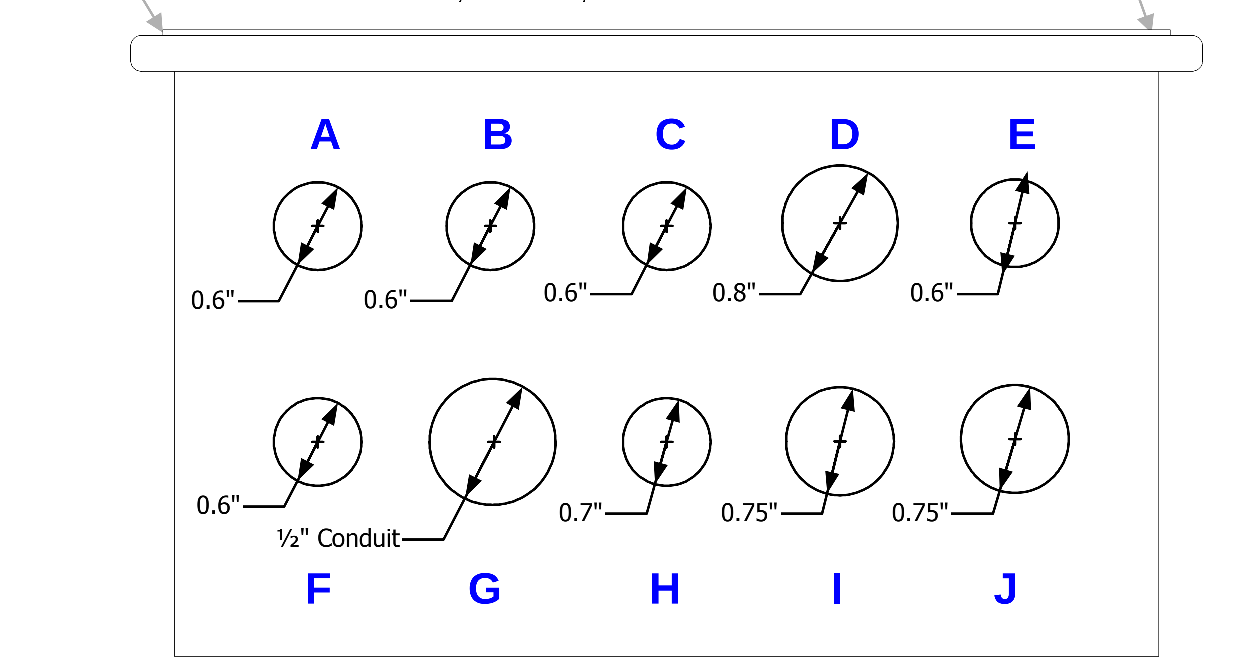


A blue tinted electrical shield, secured by two thumbscrews, covers the terminals of the **Power** board. Controllers may be supplied prewired with either 120VAC NEMA sockets or with an optional plug box. Variable frequency pump control cables may be pre-wired.

2.1.2 Enclosure Entries

Enclosure: Cable-Conduit Entries

A = PG9, Pump No.1, 39/64" or 15.2mm
B = PG9, Pump No.2, 39/64" or 15.2mm
C = PG9, Pump No.3, 39/64" or 15.2mm
D = PG13.5, Ethernet, 18.6mm
E = PG9, CTF Sensor, 39/64" or 15.2mm
F = PG9, AC Power cord, 39/64" or 15.2mm
G = ½"NPT, Solenoid, 51/64"
H = PG9, Pump No.4, 39/64" or 15.2mm
I = PG11, Pumps 6-9, ¾" or 18.4mm
J = PG11, Sensors, ¾" or 18.4mm



Warning 1:
Remove the controller frame assembly prior to drilling additional enclosure entries to prevent damage to wiring and circuit boards. The frame assembly is secured by 4 Phillips corner screws.

Warning 2:
Do not put conduit entries in the top of the enclosure.
Resulting conduit condensation and failure to seal may damage controller circuit boards.
Paralleling sensors within the enclosure cabling with AC power will cause measurement errors.

2.1.3 Wiring Rules

Analog Sensor Wiring

Analog sensors (pH, ORP, conductivity, corrosion rate, temperature, 4-20mA…), contact sets, water meters and flowswitches may be cabled in a common conduit without causing operational problems.

Do not mix AC Line, 120VAC & 240VAC wiring with any sensor or communications cable in a common conduit. Grounded, metallic conduit is preferred in areas where variable frequency drives operate.

Sensor cables, with the exception of pH sensors, may be extended in paired AWG22, 0.25mm^2 cable. Ensure that cabling splices are accessible in conduit fittings or junction boxes.

Verify that the shields on contact head water meters are also spliced when meter cables are extended. Ground cable shields at one end only to the internal frame lower bottom grounding screw.

Ethernet LAN Cabling

CAT5 LAN cabling is limited to a maximum of 300ft / 100m from controller to access hub.
Do not exceed this limit.

AC Controller Power

Power the controller using a dedicated, separate breaker in the local lighting-distribution panel.
Do not route the controller AC power in common conduit with variable frequency pump drives.

AC Power to Valves & Solenoids

Controller ON/OFF relays switch and power the AC line to valves & solenoids. Ensure that each valve & solenoid has a dedicated neutral cable between the controller and the valve or solenoid. Do not share a common neutral to multiple valves or solenoids.

Fractional Horsepower Chemical Feed Pumps

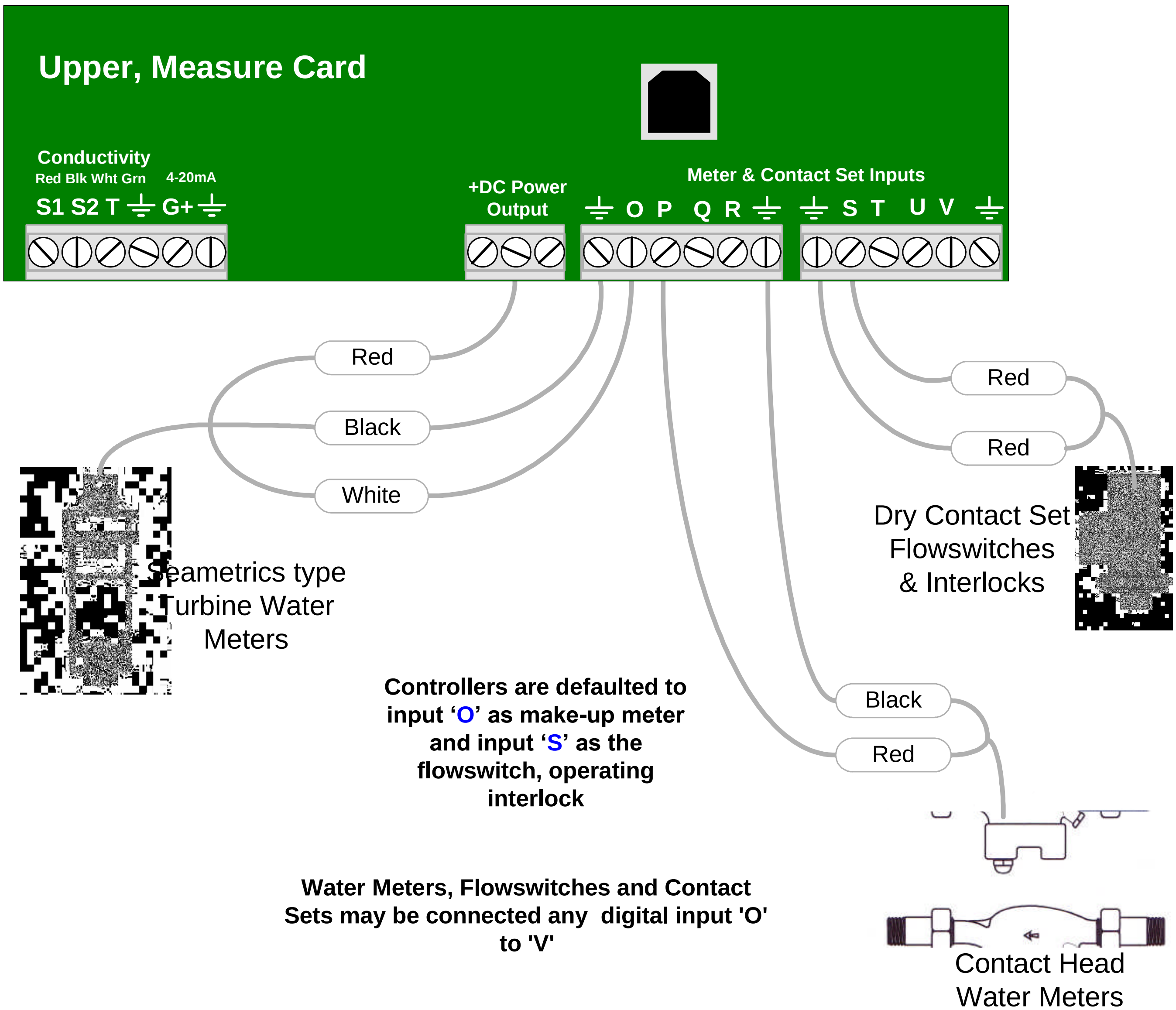
The controller ON/OFF relays are fused at 5 amps total which will power multiple solenoid driven chemical feed pumps and solenoid coils. Fractional horsepower chemical feed pumps cannot be directly powered by the controller. Use the controller 120VAC control output to switch a motor start relay with a 120VAC coil. Fractional horsepower feed pumps are commonly used in high pressure boiler chemical feed applications and waste water polymer feeds.
Typically the motor inrush current requires a dedicated breaker and separate AC feed from the controller AC power breaker.

2.2 Water Meters – Flowswitches – Contact Sets

Water meters, flowswitches and 'dry' contact sets are connected to input terminals 'O' through 'V' and a ground terminal. 5VDC limited by 10K puts 1/2mA through a closed contact set.

Hall effect Turbines and Paddlewheel water meters are powered by the 15-22VDC controller supply, thermally fused at 100mA.

Connecting Meters & Flowswitches



Connect cabling shields at the controller ends of the cable only, to any ground terminal either on the Measure card or on the aluminum backplate, bottom, center

3. Control Configuration

3.1 Control Method

3.1.1 Relays 1 to 5

Sets the deadband response of an ON/OFF relays controlled by sensors A..N.
Not applicable to relays controlled by volume meters or contact sets O..Z.

Method	Function	Examples
Rising Setpoint	ON: Sensor > Turn ON Setpoint OFF: Sensor < Turn OFF Setpoint	Tower Bleed Boiler Blowdown Condensate Bypass Acid Feed
Falling Setpoint	ON: Sensor < Turn ON Setpoint OFF: Sensor > Turn OFF Setpoint	Oxidant Feed Caustic Feed
Between Setpoints	ON: Sensor < Turn ON Setpoint & Sensor > Turn OFF Setpoint OFF: Sensor > Turn ON Setpoint Sensor < Turn OFF Setpoint	Blocking Controls Level Controls
Event Rising	Rising Setpoint Operates only during Timed Events	Acid wash – flush Cleaning controls
Event Falling	Falling Setpoint Operates only during Timed Events	Oxidant slug feeds
Event Between	Between Setpoints Operates only during Timed Events	Blocking – sequencing controls

3.1.2 Frequency Controlled Pumps 6 to 9

Sets the variable frequency control range for pumps controlled by sensors A..N.
Not applicable to pumps controlled by volume meters or contact sets O..Z.

Method	Function	Examples
Always	Frequency varies proportional to sensor value when value between setpoints ON & maximum SPM when Sensor greater than Turn ON OFF when Sensor less than TurnOFF	Proportional acid or oxidant controls. Replaces 4-20mA controlled pumps.
During Events	Control active during events until event volume pumped.	Proportional oxidant feed during a feed event.

3.2 Special Control Insight

3.2.1 Bleed & Feed Inhibitor Feeds

Bleed & Feed use is limited to sites where the bleed OR the inhibitor pump is undersized and there not enough time between bleed periods to pump inhibitor.
Bleed then Feed is the preferred inhibitor feed method for sites, which do not have a make-up water meter.
Sites which have wide variation in make-up conductivity typically will have problems maintaining the target inhibitor level using Bleed & Feed.
Poor location of feed point and bleed take-off may result in inhibitor being pumped down the drain.
Bleed setpoint dead band should be set to 1% for short bleed and short feed periods.

3.2.2 Bleed then Feed Inhibitor Feeds

Bleed then Feed is the preferred inhibitor feed method for sites that do not have a make-up or bleed water meter.
Do not use Bleed then Feed at sites where the bleed or inhibitor feed pump is undersized. There may not be enough time between bleed periods to feed inhibitor.
Sites which have wide variation in make-up conductivity typically will have problems maintaining the target inhibitor level using Bleed then Feed.
Bleed setpoint dead band should be set to 1% for short bleed then feed periods.

3.2.3 Percentage Time – Base Feed Inhibitor, Boiler Treatment, Oxidant Feeds

Commonly used method to feed boiler chemicals where a contact set closes when the boiler is on-line.
Typically boiler chemistry is verified by the operator, adjusting % time or mL/minute feed rate as required to hit the target ppm.
Reliable method of control for static systems or where users manually adjust feed rates in response to on-site testing or process changes.
Particularly useful where a contact set or flowswitch opens when the system is offline. Percentage Time or Base Feed Time controls do NOT accumulate time when the interlock is OFF.

3.2.4 Prebleed – Lockout Biocide Feeds

Used where you can't get the site to start the re-circulation pump early on biocide feed days.
Since Prebleeding dumps both inhibitor and water, avoid it if possible.
It's preferable to feed biocides into a tower that's not under thermal load where you can get the kill time at the target concentration without make-up diluting the biocide.

If you need to use this control, keep it as simple as possible. If you only need Prebleed but not Lockout, then zero the Lockout time. Lockout times that extend into the high load period may cause the tower to overcycle. On site staff may be concerned that the controller has not opened the bleed even though the conductivity is greater than the Turn On setpoint.

3.2.5 Captured Sample Boiler Blowdown Controls: Relays 1-5

Start-up

Controllers with more than one boiler blowdown control should always be commissioned one boiler at a time. It's easy to cross-wire sensors, valves and/or interlocks and very difficult to diagnose since plumbing problems are also common on start-up.
Disconnect the sensors, valves and interlocks for all boilers but one.
Verify each boiler's valve operates and its sensor measures the boiler water conductivity and it's interlock stops blowdown. Then repeat for the next boiler.

Sensor Watch

This sub-menu option on the controlling conductivity sensor is the best tool to identify plumbing problems and flashing. Read the AEGIS user manual section on Captured Sample and then view Sensor Watch through a Sample-Measure-Blowdown sequence.
If you are seeing flashing at the sensor, you are likely to have control tracking problems as the sensor tries to measure a varying mix of steam & water after the sampling valve closes. Extending the MEASURE period to 120 seconds sometimes helps but corrective action to remove the cause of flashing always improves control.

Plumbing

Make sure that the throttling valve is always downstream of the valve or solenoid and installed correctly. If you install a throttling needle valve backwards, you'll be replacing it.
The optimum control occurs when any flashing occurs downstream of the throttling valve.
This is particularly important on boilers operating at less than 100psi steam since steam rated solenoids are more sensitive to flashed deposits than motorized valves.

If this boiler previously had a continuous blowdown controller installed and did not have a throttling valve, locate the orifice union and ensure that it is downstream of the sensor and blowdown valve.

Although it's convenient to have the blowdown valve accessible so you can see the stem position, it's not necessary for the correct operation of the controller. You can install the sensor, blowdown valve and throttling valve on horizontal or vertical runs of the surface blowdown line above or below the boiler water line. Maintenance may be difficult, but blowdown function will not be compromised. The longer the piping run to the sensor, the more water you'll remove to get a sample.

Missing, Corroded or Intermittently Immersed Surface Blowdown Lines

An internal surface blowdown line that extends below the boiler water level is an option on some boilers. You'll see this fault occasionally on a new installation start-up. Sensor Watch displays a low value with not much variance, measuring only steam.

If the boiler water level drops below the bottom of the surface blowdown line as load varies you won't able to control blowdown. <u>If you are not flashing at low loads</u>, the best way to see this problem is to temporarily remove the Captured Sample special control & adjust setpoint to blowdown. If the Sensor Watch value isn't stable, the surface blowdown line is not always immersed.

Corroded surface blowdown lines are rare but not unknown.
Get suspect piping inspected during the next outage but don't use this as a cause of control problems unless you are able to eliminate all other causes.

3.2.6 Time Modulation: Relays 1-5

Application: Cycles a chemical feed pump ON/OFF, decreasing the ON time as the controlling sensor approaches the Turn OFF setpoint
Typically used for pH control, reducing acid feed as the Turn OFF setpoint is approached.
Use if you can't use a variable frequency controlled pump.

Setup: User selects a relay & selects Time Modulation Special Control
User sets Time Period in seconds, minimum 60, maximum 600 seconds.

Operation: Relay ON time = [(Control – Turn OFF Setpoint) / Deadband] x Period
where Deadband = Turn ON – Turn OFF setpoints.
Relay ON 100% of Period when Control is greater than Turn ON setpoint
Relay is OFF when Control is less than Turn OFF setpoint.

Example: Acid Pumps Turn ON = 10pH and Turn OFF = 8pH. Period = 120 seconds
At pH >= 10, Pump ON for 120 seconds in every 120 seconds
At pH = 9.5, Pump ON for 90 seconds in every 120 seconds
At pH = 9.0, Pump ON for 60 seconds in every 60 seconds
At pH = 8.5, Pump ON for 30 seconds in every 120 seconds
At pH <= 8.0, Pump OFF

Notes: Time Modulation control is not applicable when the system response time is faster than 5x the Period. In the previous Example; If the measured pH moves from 10 to 8 in less than 300 seconds, Time Modulation may not improve control.
Process buffering, pump setting, feed point and system volume all affect the response to chemical feed.
Time modulation also works on Falling Setpoints.

3.2.7P Timed Cycling: Pumps 6 to 9

Application: Large volume systems where the response to a chemical feed or control action is slow or delayed in time and continuous, proportional feed over or undershoots.
Swimming pool pH, conductivity and ORP controls are typical applications.

Setup: User selects a pump & selects Timed Cycling Special Control
User sets Period in minutes, minimum 1, maximum 360 minutes.
User sets Feed Volume in mL, minimum 1, maximum 10000 (10L, 3.785G)

Operation: Pumps setpoint volume @ MAX SPM.
Time Modulation turns OFF the pump after Feed mL.
Note: If the time to feed the user set volume is greater than the Period, the pump turns OFF for 10 seconds & then starts the next feed cycle.
This overfeed is an error in setting either the feed volume (too high) or the period (too short)
Time Modulation keeps the pump OFF for 'Period ' minutes where 'Period' is reduced by the pump feed time.
During the OFF period, the system has time to respond to the ON Time feed.

Example: Time Cycling Feed = 250mL , Period = 60 minutes
It takes 14 minutes for a 18mL/minute pump to feed 250mL so the pump is ON for 14 minutes and OFF for 46 minutes.
If the controlling sensor measures below the TurnOFF setpoint during the feed period, the pump turns OFF.

3.2.7R Timed Cycling –Relays 1 to 5

Application: Large volume systems where the response to a chemical feed or control action is delayed in time.
Swimming pool pH, conductivity and ORP controls are typical applications.

Setup: User selects a relay & selects Time Modulation Special Control
User sets ON Time in minutes, minimum 1, maximum 360 minutes.
User sets Period in minutes, minimum 1, maximum 360 minutes.
Controller forces Period >= ON Time.

Operation: Setpoint Controls turn ON the relay.
Time Modulation turns OFF the relay after ON Time minutes.
Time Modulation keeps the relay OFF for 'Period – ON Time' minutes.
During the OFF period, the system has time to respond to the ON Time feed.

Example: Time Modulation ON Time = 10 minutes, Period = 60 minutes
Brine feed is controlled on conductivity using a Falling Setpoint.
Conductivity setpoint control turns ON the Pool Brine feed relay.
After 10 minutes the Pool Brine feed turns OFF.
After another 50 minutes the Pool Brine feed turns ON for another 10 minutes if below the Turn ON setpoint or remains OFF if the conductivity is above the Turn OFF setpoint.

Notes: Condensate systems are also slow to respond to amine feed.
However the response time may vary with time of year and steam production.

3.2.8 Holding Time

Application: Holding Time averages the value of a controlling sensor over a user-defined period. Averaging lowers the effect of process transients and limits the effect of the delay between feed and measuring the effect of the feed. Control of amine feed by a pH sensor in the condensate return is a typical use of Holding Time control.

Notes: The number of samples used for control is the Period / Log Rate.
Log entries are an average over the Log Period.
You may choose to reduce the Log Period to increase response to transients or increase the Log Period to limit transient response.
The same effect may be achieved by altering the Holding Time Period.

3.2.9 Varying Cycles

Application: Cooling towers where the make-up conductivity varies widely and is measured by a separate conductivity sensor. The bleed (cycles of concentration) is controlled by the ratio of the tower-to-make up conductivity within three user set ranges. As the make-up conductivity changes, the cycles of concentration changes. Typically, at lower make-up conductivities, higher cycles of concentration are possible.

This special control solves operational problems, but requires care when setting cycles or concentration setpoints and maximum cooling tower conductivity.
If your site has seasonal changes, it's preferable to simply modify the bleed setpoints.

Warning: When the make-up conductivity falls, the bleed setpoint increases but the bulk of the water in the cooling tower has not changed.
Example: If make-up conductivity changes from 500uS to 100uS, the cycles of concentration setpoint may change from 2 cycles to 4 cycles. However @ 4 cycles, the bulk of the water in the tower may be scaling.
Short Holding Time: If the holding time (time required to exchange the tower water) is short, then the 100uS make-up will quickly dilute the tower water to below scaling.
Non-Scaling: You may not be hardness cycles limited, so even @ 4 cycles, you may not be in a scaling condition.

4. Sensors

4.1 Compensation

4.1.1 Analog Sensors A..N

Type	Setup	Notes
Thermal (Conductivity)	User selected thermal sensor A..N. User set %/degree compensation.	Applied to conductivity sensors. Zero at 70F or 20C, dependent on 'metric units' switch setting. The defaults are 0.97%/F or 1.746%/C
Thermal (pH)	User selected thermal sensor A..N.	Applied to pH sensors. Zero compensation at 7 pH. Compensation adjusts sensor gain (slope) +0.00467%/C above 25C & -0.0058%/C below 25C pH thermal compensation can only be applied to directly connected pH sensors and not to 4-20mA inputs which may represent pH.
Rate-to-Volume	User selected water meter O..Z displays and logs resulting volume. User selected rate/minute or rate/hour	Typically a 4-20mA input proportional to gpm makeup rate or LBh steam production is converted to volume to feed ON/OFF based on volume & time setpoints. Frequency controlled pumps can be controlled directly by the 4-20mA level.
Corrosion Rate	User set alloy number, default 1.00, Carbon Steel User selected conductivity sensor A..N, corrects corrosion rate for conductivity.	Controller sets alloy to default and conductivity sensor to 'none' on CR driver installation. Conductivity sensor optional. Remove driver to remove compensation.
Manual Entry		Logs the results of ppm testing or any analog value. Any analog input without a driver card, may be used for Manual Entry and phantom inputs 'H' to 'N'. Remove by setting compensation to 'none'
Calculated	Feed Verification calculated ppm log.	Remove by setting to 'none' in Feed Verify control.
Inventory	Feed Verification calculated tank volume log.	Remove by setting to 'none' in Feed Verify control. Pumped volume may also be copied to an Inventory input, reducing the tank volume by the volume pumped.

Note: pH thermal compensation is seldom used in cooling towers since the pH is typically between 7 & 8 so the effect or thermal compensation is minimal.

4.1.2 Water Meter Sensors O..Z

Switching from Contact Set to Water Meter clears the log on the switched input.

Type	Setup	Notes
Contact Head	User set volume/contact	Contact Head compensation turns ON software debouncing. Volume counts on contact closure. Contact opening ignored.
Turbine or Paddlewheel	User set ‘K’ factor, pulses/unit volume	Counts pulse on falling edge, 400Hz max. Ignores rising edge.

4.1.3 Contact Sets, Flowswitches, Fail-to-Sample Sensors O..Z

Switching from Water Meter to Contact Set clears log.

Type	Setup	Notes
Contact Set	User selects Contact Set	Contact sets are ON when closed and OFF when open. ON time is logged. Contact sets used for interlocking, prevent relays from turning ON when contact set is OFF, or open. Contact sets may be configured as ‘inverted’ to act and disply as ON when they are OFF. Contact sets may be configured to ‘mirror’ a controlled relay of frequency controlled pump, acting & displaying as ‘ON’ when the relay or pump is ‘ON’

4.2 Calibration

4.2.1 Single Point Calibration

All inputs A..Z with the exception of 4-20mA, type '**CI**' inputs, are single point calibrations. Calibration of contact set inputs is blocked.

SENSORS A..N:

Conductivity, Calculated:	Sensor **GAIN** is adjusted so that the sensor value matches the user's calibration value.
Temperature, pH, ORP & Corrosion Rate	Sensor **OFFSET** is adjusted so the sensor value matches the user's calibration value.
Inventory, Manual:	Sensor **OFFSET** is set so the sensor value matches the user's calibration value. Since the **GAIN** on these inputs is zero, the **OFFSET** is the input value for control and logging.

During calibration, users have the option to Reset to Factory, which resets the sensor **GAIN** & **OFFSET** to default values (Refer to section 4.2.3).

If the calibration **OFFSET** or **GAIN** is outside fault limits, users are offered the option to OVERRIDE. **OFFSET** or **GAIN** outside of the fault limits typically indicates a sensor, cabling or driver fault.

Users have the option to manually enter **OFFSET** and **GAIN** by selecting Sensor then Configure

The value of a sensor = Measured Level (mV) x GAIN + OFFSET.

This value may be modified by sensor compensation.
Compensation (Temperature, Rate-Volume, Corrosion Rate…) is applied after **GAIN** & **OFFSET**.

WATER METERS O..Z:
The user calibration value is Volume/contact for contact head meters and 'K' factor (Pulses per unit volume) for turbine and paddlewheel meters.

4.2.2 Two Point Calibration

Two point calibration is limited to sensor type '**CI**', the dual 4-20mA input driver.
There are no fault limits on GAIN or OFFSET for '**CI**' drivers.
Refer to Section 7.4.

4.2.3 Reset to Factory

New sensor driver cards & reconfigured water meters are Reset to Factory on Power on.
User selected Reset to Factory loads the **GAIN**, **OFFSET** set from the following table.

Sensor Type	Driver Type	Factory Gain	Factory Offset	Fault MAX	Fault MIN
Boiler – Condensate Conductivity	**B**			GAIN	GAIN
Type = Boiler		2.0	-15	10	0.5
Type = Condensate		8.0	-90	12	3.0
Calculated Value		100	0	None	none
Conductivity	**CT**			GAIN	GAIN
Range >100uS		5.6	-35	10	2.5
Range <100uS		0.4	-10	0.55	0.25
Conductivity CTF	**CTF**			GAIN	GAIN
(includes flowswitch)	**Cond.**	10.6	-13.6	14.85	6.36
				OFFSET	OFFSET
	Temp.	-0.0905	234.7	255	215
Corrosion Rate	**CR**	1	0	None	None
4-20mA Current Input	**CI**	1	0	None	None
Manual Entry		1	0	0	0
ORP - pH	**OP**			OFFSET	OFFSET
Type = pH		0.017	7	8	6
Type = ORP		-1	0	50	-50
Temperature	**CT**			OFFSET	OFFSET
US units		0.18	-459.4	-430	-590
Metric units		0.1	-273	-253	-293
Water meter					
Contact Head		100		None	None
Turbine		100			

5. Application Notes

5.1 Calculate ppm

5.1.1 Calculation Method

The controller can automatically calculate inhibitor ppm by measuring three values:

1. The volume of inhibitor pumped into the tower.
2. The volume of make-up water.
3. The cycles of concentration

And there's more than one way to measure or set the 3 values:

1. Inhibitor Volume
The volume of inhibitor can be measured by a meter installed in the output of the inhibitor pump (see **Sidebar**) or calculated by the number of strokes of a frequency controlled pump.

2. Tower Make-up
Tower make-up volume may be measured by the potable water make-up meter.
The tower may also have grey water make-up from an RO or wastewater recovery stream measured by a separate meter.
Depending on the inhibitor feed method, you may elect to sum the gray water volume to the make-up meter OR sum the Make-up & gray meters, to a third, phantom meter.
(Refer to **5.2 Copy_Volume**)

3. Cycles of Concentration
The most accurate way to measure the Cycles value is to install a water meter on the bleed line,
The ratio of the make-up volume to the bleed volume is the cycles of concentration.

If the tower make-up conductivity is constant, you can also use a fixed cycles of concentration since as long as you are in conductivity control, the cycles of concentration is fixed by the bleed setpoint.

Sidebar:
Accurate, positive displacement, 1mL/pulse Tacmina type meters may also be installed on the suction side of higher pressure, fraction HP pumps used for boiler feed.

Lower cost, stroke counters on the pump output may be accurate enough for inhibitor ppm calculations and work very well for fail-to-feed alarms.

The calculated volume fed by frequency-controlled pumps may be accurate enough for calculating ppm without calibration. Higher accuracy requires pumping from a graduated cylinder and calibrating the mL/stroke.

5.1.1 Calculation Method cont.

Calculating Inhibitor ppm

Since the inhibitor feed system includes a make-up water meter, you will be controlling inhibitor based on tower load by volume-time (ON-OFF Pump) or volume-ppm (Frequency controlled Pump) setpoints.

The ppm of inhibitor in the tower water = 1000000 x Cycles x Inhibitor Volume / Make-up Volume

Example: If the tower has made-up 25,000 gallons today & you've fed 3500mL of inhibitor & you are running 2.5 cycles of concentration.

Inhibitor ppm = 92.5 = 1,000,000 x (2.5 x 3500mL) / (3785mL/G x 25000G)

5.2.2 Configuration

Inhibitor Feed Meter: 'Chemical Volume'

Enable an unused physical meter input in the '**O**' to '**V**' range and connect the 1mL/pulse feed meter or stroke counter to the enabled input.
If you are feeding Inhibitor using a frequency controlled pump, you can use the pumped volume calculated from the pump strokes x the mL/stroke in place of an actual feed meter.

In rare cases, you may be feeding inhibitor from more than one source, perhaps a frequency controlled pump and a 1mL/stroke feed meter. If this is the case, use the 'Copy Volume to' configuration to copy both inhibitor volumes to a phantom volume input in the '**W**' to '**Z**' range.
Then use the phantom volume as the 'Chemical Volume'

The controller assumes inhibitor feed meter measures in mL, ignoring the user set units.

If you are using a pulse counter, calibrate the 'Chemical Volume' meter in mL.
For example, if you are feeding at 0.1mL pulse, configure the pulse counter as a Turbine Meter with a 'K' Factor = 10.

Tower Make-up Meter: 'Make-up Volume'

The ppm calculation converts make-up volume to mL based on the current System Units setting:
US units converts measured make-up volume x 3785 mL/Gallon.
Metric converts measured make-up volume x 1000 mL/L.

Typically meter input '**O**' is used as the cooling tower or process make-up meter.
If more than one meter is used for make-up, use the 'Copy Volume to' configuration to copy the make-up volume to a phantom volume meter in the '**W**' to '**Z**' range.

Inhibitor ppm Input: 'Calculate ppm'

Enable an unused, phantom input in the '**H**' to '**N**' range.
Use a phantom input because ppm is calculated and not a physical, wired sensor.

After you select 'Calculate ppm', you'll need to select the 'Chemical Volume' and 'Make-up Volume' meter locations in the '**O**' to '**Z**' range.

If a bleed meter is available, set 'Cycles method' to 'Meter Cycles', otherwise select 'Fixed Cycles' and set 'Cycles' to the ratio of the Cooling Tower / Feedwater Makeup conductivities.

5.2.3 Operation

Calculating inhibitor ppm starts at midnight.
Until make-up volume and chemical fed volume are measured, the displayed and logged ppm value will be zero. If you have set the ppm low alarm with a short delay on alarm, you will get nuisance alarms.

It's necessary to reset ppm calculation at midnight to avoid cumulative errors due to the accuracy limits of inhibitor feed and water volume measurement and operational error sources like tower windage.

5.2 Copy Volume

5.2.1 Copying WaterMeter & Pump Volumes

An increase in volume on one water meter '**O**' to '**Z**' can be added to another water meter, allowing the sum of one or more water meters to display, control and log on another water meter.

An increase in pumped volume on one or more of the frequency controlled pumps '**6**' to '**9**' can be added to any water meter '**O**' to '**Z**'.

The targeted water meter may be an actual, physical meter '**O**' to '**V**' or a phantom meter '**W**' to '**Z**'.
In either case, the target meter can be used for control, alarming, logging and reporting.

The increase in volume measured by any water meter input '**O**' through '**V**' or calculated for any frequency controlled pump '**6**' through '**9**' is immediately added to the target water meter

Sites with multiple make-up meters can sum to a common or phantom water meter & be used to control a single inhibitor pump.
The volume from multiple frequency-controlled pumps fed from a common tank can be used to calculate tank inventory.
Note: Pumped volumes copied to water meters '**O**' to '**Z**' are summed.
Pumped volumes copied to phantom inventory inputs '**H**' to '**N**' are subtracted.

'**Copy Volume'** allows you to use the sequential volume **O:P** type controls with more than one meter summed to '**O'** and/or '**P**'
'**Copy Volume'** allows you to sum all of the water meters connected to the controller to one totalizing meter.

5.2.2 Typical Applications

Cooling Tower with Potable & Grey Water Make-up Meters
We're using water meter input '**O**', named '**Tower Makeup**' to measure the potable water make-up and water meter input '**Q**', named '**Reclaim Makeup'** to measure the grey water.

We've enabled input '**R**', configured it as a water meter & named it, **'Total Make-up'**
We've configured both water meters '**O**' and '**Q**' to '**Copy Volume to'** water meter '**R**'

The variable frequency pump at '**8**', named **'Inhibitor Pump'** has been configured to control using water meter '**R**' with a 120 ppm setpoint.
Water meters '**O**' and '**Q**' measure make-up, increasing the volume of meter '**R**' and feeding inhibitor on pump '**8**' to maintain 120ppm

5.2.2 Typical Applications cont.

Two Frequency Controlled Inhibitor Pumps, One Inhibitor Tank Level
We've enabled phantom input '**J**', increased its resolution to 3 digits after the decimal & renamed it **Inhibitor Tank.**
We've configured frequency controlled inhibitor pumps '**6**' and '**8**' to copy pumped volume to '**J**' which automatically sets '**J**' compensation to **Inventory** and puts 100 gallons (or liters) into the tank.

We've put 40 gallons of Inhibitor into the 55 Gallon tank and using the keypad, we've calibrated **Inhibitor Tank J** to read 40.000 gallons.
We've set the **Inhibitor Tank J Low Alarm** = **10** Gallons & the **High Alarm** = **60** with the Delay on Alarm = **0** minutes.

As inhibitor is pumped from either pump '**6**' or '**9**', the displayed tank volume on the LCD display and the browser view falls.
At below 10 Gallons, an alarm shows on the LCD and the browser icon switches to the **RED** Alarm state.

5.3.3 Operation

Meters targeted by 'Copy Volume' cannot be disabled OR changed to a contact type input.

A water meter or frequency controlled pump cannot be copied more than once.
So you cannot copy meter '**Q**' to both meters '**X**' & '**Y**'. However two meters can be copied to a third meter and a fourth meter can be copied to a fifth meter up to the maximum of 12 meter inputs in any one controller

In the limit, 11 meters, '**O**' to '**Y**' can be copied to meter 12, '**Z**'.
Note that 3 of the 11 meters, '**W**' to '**Y**' are phantom meters representing either rate-to-volume conversions and/or volumes of frequency-controlled pumps.

NOTE:
If the '**Copy Volume to**' option does not appear, then this meter is the target of 'Copy Volume' and therefore cannot not be 'Copied' to any other meter, blocking an infinite count.

Diagnostic:
Selecting **Sensor/Diagnostic** for a water meter that is the 'Copy Volume' target for another water meter or pump volume will display **Status: Target Meter**

Constraints:

1. Any water meter used to sum volumes from other meters cannot be set to 'Copy Volume' to prevent an inadvertent infinite count when you sum to a meter which 'Copies' to the originating meter.
2. You cannot disable a water meter with 'Copy Volume' set or make it into a contact input until you set the 'Copy' compensation to 'none'
3. You cannot disable the target meter of a meter set to 'Copy Volume' until all of the meters targeting the summing meter are either targeted on other meters OR have the 'Copy Volume' set to 'none'
4. Rate-to-Volume compensation volume incremental values are copied between water meters.
5. All meters must use the same units to sum volumes or the sum has no meaning.

5.3 Feed Verify & Inventory

5.3.1 Methods

Any water meter input may used to verify flow while a pump, solenoid or valve is ON.
Once the user set a time limit for an increase in volume expires, a 'Fail-to-Feed' alarm occurs.

Any water meter's measured volume can be directed to any analog sensor input '**H**' through '**N**' and used to calculate tank inventory.

Volume Meters: Verify Feed
Chemical Pumps may have a precise 1mL/pulse positive displacement Tacmina type sensor on the pump output tubing OR a switch on the pump outlet that provides a contact closure every time the pump strokes.
Water Meters: Verify Bleed, Blowdown, Drawdown, Make-up
Contact head or turbine type water meters may be installed on make-up, bleed, drain or dilution piping to verify that the valve or solenoid has operated or opened and flow is not blocked or valved off.

Tank Inventory
The volume measured by any water meter input '**O**' through '**V**' or calculated for any frequency controlled pump '**6**' through '**9**' is subtracted from the input used to display & log tank volume. .

When you add liquid to the tank, you tell the controller the new tank volume by Calibrating the sensor input '**H**' through '**N**' used as an **Inventory** target.
Any sensor input or inputs '**H**' through '**N**' may be used to calculate volume.

If more than one pump is drawing from the same tank:

1. Use the same Inventory sensor location for each pump & measuring meter
2. Refer to the previous **Copy_Volume** application note.

5.3.2 Typical Feed Verify Applications

Verifying an Inhibitor Feed
The inhibitor pump controlled by relay 1, has a device on its output that provides a contact closure every time the pump strokes. We're going to use it to verify that we're actually feeding inhibitor.
We've enabled unused meter input '**Q**', and named it **Inhibitor Verify**.

We've configured **Inhibitor Verify Q** with Compensation = Feed Verify and Verify Output = 1:Inhibitor.
We've left the Wait-to-Verify at the default 30 seconds.

Each time the Inhibitor Pump turns ON, the controller verifies that a contact closure is measured by **Inhibitor Verify Q** every 30 seconds or less. 30 seconds ensures that even at a low stroke rate, we'll see a contact closure every 30 seconds unless we've lost prime, emptied the drum, blocked a feed…

If **Inhibitor Verify Q** does not measure a contact closure every 30 seconds while the Inhibitor Pump in ON, **Q** will alarm.

5.3.2 Typical Feed Verify Applications cont.

Verifying a Bleed

We're using the bleed in this example, but the same method can be used to verify that any valve or solenoid actually operated and flow is occurring.

Debris occasionally blocks the bleed & while we alarm on high conductivity we'd like to know as soon as the bleed fails.
We've using the existing bleed meter input '**P**', named **Bleed Volume**.

We've configured **Bleed Volume** **P** with Compensation = Feed Verify and Verify Output = 2:Tower Bleed.
We've extended the Wait-to-Verify from the default 30 seconds to 300 seconds or 5 minutes.
Bleed Volume **P** is a 10 Gallons/contact meter & it takes some time after the bleed opens to measure 10 Gallons.

Each time the Bleed turns ON, the controller verifies that a contact closure is measured by **Bleed Volume** **P** every 300 seconds or less.
If **Bleed Volume** **P** does not measure a contact closure every 5 minutes while the Bleed in ON, **P** will alarm.

Note: Feed verify compensation does not prevent meter P from being used elsewhere in the controller for control, ppm calculations, O:P sequential feeds and P may be copied to other meters to sum discharge.

5.4 Frequency Controlled Pumps

5.4.2 Feed Rate Setting

The controller knows the pump's mL/stroke and maximum stroke rate (Maximum SPM).
Once you select the pump feed method or control mode, the controller sets the optimum Pump Speed.

Modes	User Sets	Pump Speed
Sensor Controlled **pH** **ORP**	**TurnOFF :** pH or ORP setpoint **100%ON :** pH or ORP setpoint Proportional control.	**pH:** As the tower cycles up, the pH rises. The acid pump is OFF at pH < TurnOFF. The pump speed increases linearly between TurnOFF and 100%ON setpoints. **ORP:** As the tower operates bleach is consumed and the ORP falls. The hypochlorite pump is OFF at ORP > TurnOFF The pump speed increases linearly between TurnOFF and 100%ON setpoints.
Water Meter ppm Controlled	**Measure:** Volume measured on meter **Feed:** ppm of product to feed	The tower make-up meter measures volume. The controller turns ON the pump at Maximum SPM, adding the volume required to meet the ppm setpoint. *Example: Measure 250 Gallons, Feed 125 ppm*
Bleed & Feed Inhibitor	mL/minute setpoint	Inhibitor Pump ON when Bleed Solenoid ON.
Bleed then Feed Inhibitor	mL/minute setpoint	Inhibitor pump feeds at maximum SPM as soon as bleed solenoid turns OFF. Volume fed proportional to time bleed solenoid ON.
Base Feed	mL/minute setpoint	Pump feeds at user set rate unless flowswitch turns OFF feed.
Biocide Feed Events	Start Day# & Time Feed Volume	Pumps user set volume at maximum SPM after Prebleed.
Timed Cycling	User sets cycle period in minutes and ON volume in mL.	Pumps user set volume (1mL to 10L) at maximum SPM at the start every user set period if above TurnON setpoint.
Contact Set Controls	TurnON seconds TurnOFF seconds	TurnON@ user set seconds after contacts close & display 'ON' Turn OFF user set seconds after TurnON . Fed at maximum SPM.

5.4.2 Technical: Frequency-Stroke Controls

1 Gallon = 3785 mL. **Set pump frequency control to External & Stroke to 100%**
GPH = Gallons per hour **GPD = Gallons per day**

Pump Defaults – User Adjustment Range & Resolution

Pump default mL/stroke is set for a 40psi head, typical for cooling tower chemical injection piping.
The user mL/stroke adjust is limited to +25% and –70% for ProMinent pumps.
The user mL/stroke adjust is limited to 0.01mL/stroke and 10ml/stroke for 'Other' type pumps.
In both cases the adjust resolution is 0.01mL

'Other' type Pump spm rates are limited to a minimum of 50 spm and a maximum of 400 spm

Maximum Feed Rate

A pump's maximum feed rated is it's rated maximum strokes/minute x mL/stroke.
Example: A ProMinent 1602 pump is rated 180spm with a default of 0.24 mL/stroke
The maximum feed rate for this pump = 180 x 0.24 x 60 = 2592 mL/hour,
0.685 GPH, 15.44 GPD
At the –70% minimum user adjust: 0.78 L/hour, 0.2 GPH
At the +25% maximum user adjust: 3.24 L/hour, 0.856 GPH

Minimum Feed Rate or Turn Down

The minimum pump frequency is set to 0.1 SPM; a turn down of 1800:1 for a 180 SPM pump and 2400:1 for a 240 SPM pump.
The 0.1 SPM limit turns the pump drive LED ON for 5 minutes and OFF for five minutes; a maximum for an observer visually verifying that a pump is stroking.

Minimum feed rate only applies to pumps that are controlled by analog sensors; pH, ORP, temperature, flow rate…
Other pump controls operate at either the user set mL/minute or MAX SPM, so minimum feed rate is not applicable.

Control Resolution

Control resolution = 1mS. I 1mS defines the precision of variable frequency control
Example: At 180 spm, a 1mS control resolution is 667 feed rates
At 10 spm, a 1mS control resolution is 6000 feed rates

As the example clarifies, control resolution is more important at high pump speeds.
Between 179 and 180 spm, there are 667 possible feed rates.

For a pump operating at 400 spm, the control resolution 150 feed rates

Setpoint Resolution

Setpoints for 'Base Feed', 'Bleed & Feed' and 'Bleed then Feed' mL/minute have 0.01mL resolution.
The resolution limit matches the user adjustable mL/stroke resolution

Setpoints for 'ppm' are integers.
Setpoints for volume meters are integers @ user set resolution.
Setpoints for biocide feed volumes are 0.01G resolution.

5.4.2 Technical: Frequency-Stroke Controls cont.

Setpoint Range Response
When the user adjusts the mL/minute feed setpoint OR selects a new pump OR adjusts the pump mL/stroke setting, the controller verifies that the new setting or pump can deliver the required feed rate.

If the pump cannot deliver the required feed rate to meet the current setpoints, the controller sets the pump to its maximum feed rate and notifies the user that the pump is maxed.

Volume Accuracy
For most applications, the default mL/stroke accuracy is applicable since users will adjust feed rates based on wet chemistry test results. In this context, repeatability and linearity are more important for concentration control than mL/stroke accuracy.

Error sources extend beyond the pump control accuracy to the precision of feed chemical blending, wet chemistry test accuracy & resolution …

1. If your wet chemistry shows a 10% higher than expected ppm. Lower the mL/stroke setting for the inhibitor pump by 10%. Don’t change the feed setpoints.

2. If you are interested is tracking down ppm error sources, start by pumping 100mL from a graduated cylinder and adjusting the pump mL/stroke to correct for the displayed increase in volume pumped.

5.5 Password Security

5.5.1 Overview

AEGIS controllers use 4 levels of password for controller access and to stamp the activity log:
Public Operator Maintenance Administrator
Refer to Section 6.5.4 for default user IDs and passwords.

Passwords are defaulted OFF for keypad users and ON for browser users.
Passwords cannot be turned OFF for browser users.

There are 7 user configurable passwords which are distributed between Operators & Configurers.

Passwords are a maximum of 9 letters and numbers and are case sensitive. The controller blocks the use of HTML delimiter characters by limiting password content to letters and numbers only.

The controller blocks duplicate passwords since the password identifies the user on keypad log in.

5.5.2 Password Level Activities

Password Level	*Activities*	*Notes*
Public **1 per AEGIS**	Views current state and clears alarms, select System or Diagnostic view. Cannot adjust or edit.	Password not required for keypad or browser use. Browser access to controller wide alarm reset only.
Operator **1..7 per AEGIS** **default 4**	Calibrate sensors. Prime Pumps. Set 4 & 20mA levels. Changes setpoints and feed rates. Can view but not edit all controller configure level settings	Can edit own user ID & password. Keypad users, password only editing. Controller default user ID is **Operator1** thru **Operator4** with default passwords 1..4.
Configure **1..7 per AEGIS** **default 3**	Configure controls, interlocks and blocking. Sets sensor compensation, feed alarms & limits. Sets biocide timing, Prebleed, Lockout & cycle days. Zeroes water meters All Operator Activities	Can edit own user ID & password. Keypad users, password only editing. Controller default user ID is **Configure5** thru **Configure7** with default passwords 5..7.
Administrator **1 per AEGIS**	Set IP address and network parameters. All Operator & Configure Activities	Browser: Can define other users as **Operator** or **Configure** Cannot view other users passwords. Can edit own password, default ‘AAAA’ Cannot edit ‘Admin’ user id

5.5.3 Browser Passwords & Lockout

After 5 unsuccessful attempts to log on, the controller locks out both Ethernet and modem access
Locked out users will see an **Alarmed** status message in place of **Password Incorrect** .

Browser & modem resets at 7:00AM or when AC power OFF/ON.
Therefore the maximum lockout time is 24 hours and the minimum is less than a minute.

This feature blocks scripting attacks on controllers and cannot be disabled.
There is no limit on the number of keypad password attempts.

Changing all passwords from their default values is strongly recommended for Ethernet and modem connected controllers.

Passwords can be reset to the factory default by logging on as the **Reset Pswrds** user.
Refer to Section 6.5.5

5.5.4 LCD Passwords

Passwords are defaulted OFF for keypad users.

The **System/Password** menu item does not display unless **System/Configure** has turned passwords ON.
Once passwords are turned ON, only the administrator can access **System/Configure** to turn Passwords OFF

If passwords are ON, you are prompted with the required password level; **Admin / Configure / Operate** when you attempt to execute a command which reconfigures the controller.
Passwords are not required to view the current state.

Default Passwords & User IDs

User Type	User ID	Default Password
Operator	Operator1 Operator2 Operator3 Operator4	1 2 3 4
Configure	Configure5 Configure6 Configure7	5 6 7
Administrator	admin	AAAA

Kepypad-LCD access cannot change User Type or ID.

NOTE1: If you are going to use keypad passwords, your first action after turning passwords ON should be to change the admin and all other passwords since leaving any password at it’s default value bypasses password protection.
NOTE2: Only the ‘admin’ user can load a new controller view-configuration.

5.5.5 Password Reset

Contact Aquatrac with the controller serial number to obtain a reset password which resets all passwords to the Section 5.5.4 factory defaults.
Proof of controller ownership is understandably required.
AEGIS controllers have no backdoor or super user password.
If you forget the password, this is the way to recover controller access.

5.6 Relay & Frequency Controls Comparison

ON/OFF Controls :
Relays **R1** to **R5** are used for ON/OFF controls.
The relay switches 120VAC ON or OFF, powering pumps, solenoids and motorized valves.

Frequency Controls :
P6 to **P9** pulse outputs control pump frequency. The pump is always plugged into an AC supply and the pumping rate is set by the frequency of pulses from the controller.

Modes	Frequency Controls	ON/OFF Controls
Control Setpoints	**Sensors:** Setpoints are TurnOFF & 100%ON Proportional variable frequency control. **Meters:** Setpoints are ppm & volume. **Contact Sets: See Notes 1** Setpoints are seconds & feed volume In mL 100%ON @ user set seconds after contacts close then feed setpoint volume.	**Sensors:** Setpoints are TurnOFF & TurnON Relay is OFF or ON. **Meters:** Setpoints are volume & ON time. **Contact Sets: See Notes 1** Setpoints are seconds. TurnON@ user set seconds after contacts close. Turn OFF user set seconds after ON.
Control Equations	Up to four **Sensors** OR up to four **Water meters** OR one **Contact Set**. **Sensors** may use '+','-','x' or '/' operators. **Watermeters** may use '+', sum operator.	Up to four **Sensors** OR up to four **Water meters** OR one **Contact Set**. **Sensors** may use '+','-','x' or '/' operators. **Watermeters** may use '+', sum & ':', sequential operators.
Timed Events	User sets event volume. Event ends on volume fed	User sets ON time. Event ends when time elapsed.
Data Logging	Logs volume fed in each log interval	Log ON time in each log interval
Feed Limits	Limit = Volume per Feed @ MAX SPM Limit = Volume/Day **Notes 2**	Limit = Time ON per actuation Limit = Time ON /Day **Notes 2**
Fail to Feed or Bleed	A watermeter input must measure a count every user set seconds at any non zero control frequency. **Notes 3**	A watermeter input must measure a count within a user set seconds of turning on the control relay. **Notes 3**
Control Method	'Aways' OR 'During Events'	Rising, Falling & Between setpoints. OR Rising, Falling & Between during events.

5.6 Relay & Frequency Controls Comparison cont.

Modes	Frequency Controls	ON/OFF Controls
Blocking	Up to 4 Relay or Frequency controls may block . Blocks on any Relay ON or any Frequency at a non-zero SPM.	Up to 4 Relay or Frequency controls may block . Blocks on any Relay ON or any Frequency at a non-zero SPM.
Interlocking	Up to 4 **Contact Sets** may interlock.. **Contact Sets** may be ORed or ANDed	Up to 4 **Contact Sets** may interlock.. **Contact Sets** may be ORed or ANDed
Bleed & Feed	User sets mL/minute. Feed ON when bleed ON. Controller blocks setpoints greater than pump mL/min x MAX SPM	Feed ON for user set % of every 5 minutes that bleed is ON
Bleed then Feed	User set mL/minute on Bleed ON time to calculate volume owed. Feeds at MAX SPM when bleed turns OFF	User sets % of 5 minutes of each bleed ON time. Feeds after bleed turns OFF.
% Time or 'Base Feed'	User set mL/minute Controller blocks setpoints greater than pump mL/min x MAX SPM	User sets % of every 5 minutes ON time.
PreBleed Lockout	User sets Prebleed time & conductivity limits. User sets Lockout time.	User sets Prebleed time & conductivity limits. User sets Lockout time.
Captured Sample	**Not applicable**	User sets SAMPLE, MEASURE, BLOWDOWN & WAIT times.
Time Modulation	**Not applicable**	Pump ON time reduced as sensor approaches TurnOFF setpoint.
Timed Cycling	User sets cycle period in minutes and ON volume in mL.	User sets cycle period in minutes and ON time in minutes.
Holding Time	User sets holding time in minutes Sensor value averaged over the holding time.	User sets holding time in minutes Sensor value averaged over the holding time.
Feed Verification	**Meter control. Not applicable to Pumps** **Notes 3**	**Meter control. Not applicable to Relays** **Notes 3**
Variable Cycles	**Not applicable**	User sets three cycles of concentration setpoints and a maximum conductivity.
Pump Type Selection	User selects Pump Type which sets default mL/stroke & Max. SPM.. 'Other' type allow user to set MAX SPM. All types allow user to modify mL/stroke. Checks that existing feed rates are possible when user changes pumps or set to MAX SPM and alarm message if feed rate modified. Pump changes update the event log.	**Not applicable**
Copy Volume to	Sums to water meters. Subtracts from Sensors (Inventory) **Notes 4**	**Not applicable**

5.6 Relay & Frequency Controls Comparison cont.

Notes	
1.	**Contact Sets** Runs once per controlling contact closure. In addition to being able to use Contact sets to turn ON & OFF relays and frequency controls, contact sets can have the following compensation: **Mirror:** Contact set Closed when user set output ON and OPEN when output OFF. May be used with phantom contact sets U to Z. *If used with inputs O to T, the physical input is ignored by the controller.* **Invert ON/OFF:** Switches the logical sense of the contact set so you can control on contacts opening and if you also select **Mirror**, a relay turning OFF **Applications: Allows a control only when relay changes state** Flushing or priming feed headers. Day tank fill, drain, filter backwash or mixer sequence controls Neutralization timing controls.
2.	**Feed Limits** Users may set **OFF on Alarm**, turning OFF a Relay or Frequency on limit. Users may also set **Midnite Reset** to reset a feed limited output at midnight
3.	**Feed Verify Bleed Verify** Users may set **Feed Verify** compensation on any water meter by selecting the Relay or Frequency output and the **Wait-to-Verify** delay to alarm in seconds. Allowing a variable delay to alarm widens applications and supports very low feed rates. User selects **Verify Output** pump, valve or solenoid. User selects optional **Inventory Location** and fed volume is subtracted from the tank volume.
4.	**Copy Volume to** Users may copy the volume pumped to any water meter input, summing the pumped volume with the meter-measured volume. Meters may also be copied to other meters **Inventory** Users may also copy the pump volume to a sensor input where the volume pumped is subtracted from the tank volume. More than one frequency controlled pump volume may be subtracted from a single tank.

5.7 System Alarms & Indicating LEDs

5.7.1 System Alarms

Alarms not specific to any sensor or control.

Name	Alarm Message & Cause	Effect
Relay 1-5 Fuse	"**Fuse opens**" AC line Fuse faults, opens @ 5 Amps to the solenoids, valves & pumps powered by Relays 1 to 5	120-230VAC Pumps, solenoids & valves OFF. Data logging on R1 to R5 shows zero ON time. Variable frequency controls continue to operate.
15VDC External	"**Low Alarm**" Wiring errors or a fault on any sensor powered by the controller 15-20VDC 'DC Power Output' supply	Correct wiring. Remove defective sensor. 15VDC thermal fuse auto-recovers. While alarmed: sensors, meters and current loops powered by the 15VDC supply will not operate.
Internal 2.5V	"**Out of Range**" Sensor, meter or contact set wring error or driver card fault.	Used to auto-calibrate all sensor measurements to remove power supply drift error. All sensor measurements stop auto-calibration.
Power-on fault	"**Controls Removed**" One or both sensor driver cards have been removed or type changed.	The pump or solenoid controlled by the removed sensor turns OFF. Re-configure the control.

5.7.2 Indicating LEDs

Name	Location	Function
Running	Front Measure board Right side center	ON when the controlling processor on the upper measure circuit board is communicating with processor that measures water meters and contact sets and supports a USB connection.. OFF when the USB password is accepted & the controller is OFFLINE.
RUN	Back Power board above the NEUTRALS wiring block	ON when the controlling processor on the upper measure circuit board is communicating with the lower power control processor. ON when the AC line fuse powering R1 to R5 is NOT open. OFF when the USB password is accepted & the controller is OFFLINE.
R1, R2 **R3, R4** **R5**	Lower Power board Above Relay1 to Relay5 AC wiring terminals	ON whenever the Relay is ON. ON when the **NO** wiring terminal is at the AC power voltage.
P6,P7 **P8,P9**	Lower Power board Above Pump6 to Pump8 control Cable terminal	ON for 50% of the pump frequency period. Mirrors the time that the electronic contact set pulsing the pump is closed. **Example:** A pump running at 10 SPM would have it's indicating LED on for 3 Seconds and OFF 3 Seconds since 10 Strokes/Minute is a 6 second period & 5.5% of rated for a 180SPM rated pump.
	LCD Backlight	ON when the controller is AC powered and its internal 5VDC supply is @ 5VDC.

5.8 Units for Volumes & Temperatures

5.8.1 Metric – US Units Selection

Controller units are selected by the **Metric/US Units** keypad and/or browser switch.

Although the increasing use of ppm controls and frequency controlled pumps moves more sites to **Metric** units, the familiarity with gallons of feedwater make-up and GPM recirculation rates indicates that sites will continue to use both unit systems.
This application note details how the controller applies the **Metric/US Units** switch setting.

Warning: Sensor values, meter and pumped volumes are logged with the units applicable at the time of log entry. Typically the **Metric/US Units** switch is set once, when the controller is commissioned, since changing units causes problems with interpreting data logs, & adjusting feed, timeout and alarm setpoints.

5.8.2 Water Meter Volumes

The measured and displayed water meter volumes, volume per contact, K Factor and the high and low alarms are all in the units set by the **Metric/US Units** switch.

Although the user set units for each volume meter and sensor input are ignored, you may mix volume units as long as you don't combine volumes measured with different units.

US Units: All volumes measured in Gallons.
Metric: All volumes in Liters

Zeroing a Water Meter
Switching a water meter to a contact set and then back to a water meter will zero the meter and set the default units to L or Gal, depending on the **Metric/US Units** switch.

Rate-to-Volume
The rate displaying on the sensor input converts to a volume based only on the Rate Minute / Rate Hour switch setting. If you are measuring rate in GPM or LPM then the volume logged by the target water is in Gallons or Liters respectively.
Note that in both examples the volume units are set by the measured rate units and not by the **Metric/US Units** switch.

Example1: A stream demand meter measuring 1200 lbs/hour, would increase the volume on the target meter by 20 lbs per minute, 28,800lbs/day.
Set the units on the target meter to 'lbs'.

Example2: An RO waste meter measuring 10 GPM, would increase the volume on the target meter by 10 gallons per minute, 600 gallons for every hour.
Set the units on the target meter to 'gal'.

5.8.2 Water Meter Volumes cont.

Copy Volume to:
Copying between water meters uses the units set by the **Metric/US Units** switch.
Copying a volume from a frequency controlled pump to a water meter converts mL to Gallons if the **Metric/US Units** switch is set to **US Units.**
Copying a volume from a frequency controlled pump to a an **Inventory** sensor input, converts pump mL to either Liters or Gallons depending on the **Metric/US Units** switch setting.

5.8.3 Pump Volumes

Frequency controlled pump volumes are measured in mL.
The **Metric/US Units** switch selects the display units for volumes greater than 100mL.

Frequency controlled pumps are specified in mL/stroke with mL/stroke calibration limits enforced by the controller.

Unit Conversion:	mL to Gallons	multiply mL x 0.0002642
	Liters to Gallons	multiply L x 0.2642

5.8.4 Inventory Volumes

Tank inventory volumes are calculated using the units set by the **Metric/US Units** switch.
The user set units for a sensor input '**H**' to '**N**' used for Inventory are ignored.

The controller converts the mL pumped by the frequency controlled pumps to either Gallons or Liters, depending on the setting of the **Metric/US Units** switch.

If you are using a water meter input volume to calculate inventory, the controller assumes that the meter is measuring in mL. The controller converts the measured mL to Gallons or Liters prior to adjusting the inventory level.

If you are using pumped volume from a frequency controlled pump to calculate inventory, the controller applies the correct conversion when calculating inventory based on the setting of the **Metric/US Units** switch.

5.8.5 1mL/Pulse Meters

In addition to the Tacmina 1mL/pulse feed meters, there are a number of devices and some pumps, which provide a contact closure or pulse on pumped volume. In all cases, the controller assumes that the volume represented by the pulse or contact closure is measured in mL.

Set the Volume/contact for the Tacmina or volume measuring device to the correct mL value.
The controller will make the correct assumptions.

The mL assumption is required for two controller sensor compensations & not required for type of control:

1. **Inventory:** The drum or tote volume is reduced as the volume meter measures.
2. **ppm:** The volume of inhibitor pumped in mL is used to calculate ppm using the volume of make-up (in Gallons or Liters) and the cycles of concentration.
3. **Sequential Meter Feed:** The **O:P** sequential control equation may use either a Tacmina type volume meter(mL) or a bleed meter(L or Gallons) for meter **'P'**. In either case, control is unaffected by either volume meter's units.

Warning: Do not sum volume meters with different units. The result is meaningless.
For example you can sum make-up meters and you can sum feed verify meters, but you cannot sum a Make-up meter (Gallons or Liters) and a Feed Verify meter (mL).

5.8.6 Temperatures

Temperature default units are set by the **Metric/US Units** switch for each input, which measures a temperature and is then used for each conductivity or pH sensor, which may be temperature compensated.

Default offsets & gains for thermal sensors are set to the defaults corresponding to the **Metric/US Units** switch.

US Units: Temperature units = 'F'. Metric: Temperature units = 'C'.

Warning: Remember that even if you change the default units on a temperature input, the controller internally applies the units set by the **Metric/US Units** switch.

Aquatrac strongly recommends that you do not change the default units on any temperature used for control or for temperature compensation of conductivity or pH. Errors in both temperature calibration and tracking over temperature for conductivity and/or temperature compensated pH will result.

5.8.7 User Assigned Units

User assigned units have no effect on controller volumes, inventory, ppm and temperature compensation calculations.

You are free to assign whatever units you wish and to mix unit types in any one controller bearing in mind how the controller handles unit conversions in Metric & US Units modes.

If you need to override the units on any input, you can edit the OFFSET & GAIN that's applied to the target input.

5.9 XML: URL Encoded Requests

This application note details the syntax used for URL encoded XML data log upload commands.

URL encoded commands are formatted as: **URL/taco.cgi?F0 = Field0Value & F1 = Field1Value** ….
Where URL = IP address of the AEGIS controller.

Example using the AEGIS default IP: http//10.10.6.106/taco.cgi?F0=CL&F1=AAAA&F2=G
Logs in as admin & requests Sensor Input 'G' log using the default value for F3

Command	Command# : Syntax : Password	Function & notes
CL	CL: Communications Log F0 F1 **CL [Password]** F2 **[I/O A..Z or 1..9 or 0 = system]** F3 **[Report Type, Defaults to log]** F4 **[Number of log entries]**	**F1** Any valid password @ Operate, Configure or Admin level. Password also logs into the controller by setting the userid cookie. One valid password provides both log & browser access. **F2** Inputs A..Z as caps. Outputs 1..9 Defaults to zero & system **F3** No F3 value gets the log for an I/O or default System report. **F4** No F4 value gets all entries Most recent entry first allows data base updates based on log period & most recent data base entry.

Action on incorrect password: XML Header only confirms command rec'd. No controller data sent. Five incorrect passwords disconnect until 7:00 AM. Identical to password response on browser log-in
Action on disabled I/O: XML header only.

F3 Value	F2 Field	Notes
0 **or 'none'**	**F2 = A..Z, 1..9** Header & Data log **F2 = 0, System** 35 Character enabled string '**A..Z1..9**' With disabled I/O as 'spaces. Alarmed I/O string + 'SYS' if System Alarmed	Data logs are most recent first. Request enabled parameters first as http//10.10.6.106/taco.cgi?F0=CL&F1=AAAA&F2=0 Non-zero F3 values will be used for future reporting.

Action on illegal F3 values: Same response as zero or 'none'.

6. Applications

6.1 Adjusting Inhibitor Feed with Varying Cycles

6.1.1 Problem

Varying Cycles changes the cooling tower cycles of concentration as the make-up conductivity varies.
You are likely to require more or less inhibitor feed at different cycles of concentration.
This application explains how to adjust the inhibitor feed rate as the make-up conductivity varies.

The inhibitor is fed proportional to make-up or bleed volume, controlled by a make-up or bleed water meter. As the load on the tower increases, more water is required & more inhibitor is fed to maintain a constant, target ppm in the recirculating cooling water.

Note: This solution can be generalized to applications where you need to use a continuously reading sensor (temperature, pH, corrosion rate, ORP…) to modify a feed rate based on an incremental volume measurement.

6.1.2 Setup: Controller Configuration

I/O Usage	Function, Configuration	Notes
'**O**' Tower Make-up	Measures make-up water volume.	Use '**P**' if bleed meter controlling inhibitor
'**E**' Make-up Cond.	Measures make-up conductivity.	
'**6**' Inhibitor Pump	Controlled by '**E**'. Interlocked by '**X**' Setpoints reflect the expected range of make-up conductivity.	Use '**1**' if ON/OFF inhibitor pump
'**9**' Feed Track	Unused pump controlled by '**O**'	Set the pump '**9**' and pump '**6**' pump types to be the same so that both max. SPM & ml/stroke match.
'**X**' Feed State	ON when '**9**' Feed Track ON '**X**' is configured to ***mirror*** '**9**'	'Mirroring' turns ON '**X**' whenever '**9**' is ON. '**X**' is a phantom input enabled to track the state of pump '**9**'.

6.1.3 Solution

We configured the Aegis controllers as detailed in Section 6.1.2 & now we'll add site specific setpoints.

Example: We expect the tower make-up conductivity to vary between 500uS and 100uS.
At 500uS we need to feed @ 50ppm and at 100uS we need to feed at 20ppm.

Control	Configuration	Notes
'**9**' Feed Track	Measure volume = 100 Gallons Then feed = 50 ppm	Set to the feed rate @ 500uS, the maximum make-up conductivity
'**6**' Inhibitor Pump	100% ON = 500uS Turn OFF = -167 uS	Setpoints are uS but the difference between setpoints is set by the target ppm range.

When the make-up conductivity is 500uS, pumps 9 & 6 feed the same amount; whatever's required to maintain 50 ppm of inhibitor.

At 100uS we need to feed 20ppm which is 20/50 or 40% of the 500uS rate.
The full range of control from 0% to 100% is therefore (500 – 100) / 0.4 = 667uS.
If 500uS is 100% than 0% = 500uS – 667uS = -167uS.

Let's check:
At 300uS we should be feeding @ 35ppm or at 70% of the 50ppm rate.
Actual pump speed = (300 +167) / 667 x 100% = 70%., OK!

6.1.4 Summary & Options

We're using a sensor value to modify the feed rate of a chemical fed proportional to a water meter volume.

We've used a simple example however there are many permutations that add flexibility:

A. You could frequency limit one of the pumps by setting it's type to 'other'. Handy if all you have is an oversized pump & usually preferred over reducing the stroke.
B. You can modify the ml/stroke for the Feed rack and/or Inhibitor Pumps.
C. You can control the Inhibitor pump on the difference between Temperature & Make-up Conductivity. As the temperature increases, the difference decreases & you feed more inhibitor.

7. Sensor Driver Card Manuals

7.1 CT: Conductivity Temperature

Safety
5 VDC, 1V AC maximum on field wiring terminals.
24 VDC maximum on internal card surfaces.

7.1.1 Installation

Services
The CT driver measures conductivity and temperature, connecting to a single immersed sensor.
Usually the sensor is installed in a cooling tower recirculating loop, although thermally compensated sensors may be installed in condensate streams, RO piping, downstream of sample coolers on boiler blowdowns…
Up to 2 CT's may be installed in an Aegis controller in addition to the fixed '**A**' & '**B**' inputs which can be configured to be a third CT driver.
Thermal compensation of conductivity is provided by the controller software.

Card Installation
1. Turn OFF the controller AC power
2. CT driver cards may be installed in either the Sensors 'C' & 'D' or Sensors 'E' & 'F' slot.
3. Turn ON the controller after installing the CT Driver and the controller will auto-configure, displaying both conductivity and temperature on the LCD display and browser.

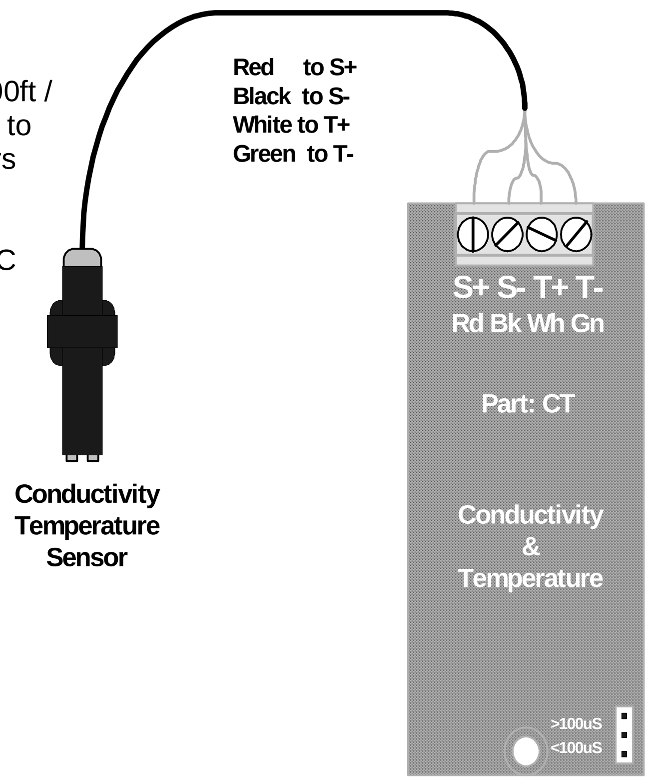
Sensor Types
Aquatrac type A261200, A261205 cooling tower and A261016 hot water, boiler-condensate sensors
These sensors contain a 10mV/K type sensor rated up 125C.

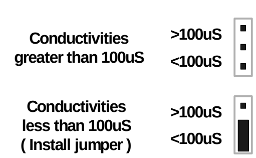
Sensor Wiring

Conductivity sensor cabling may be extended up to 200ft / 60m, using two pair AWG22 / 0.25 mm^2, cable spliced to the sensor cable using wire nuts or crimped connectors located in an electrical fitting or enclosure.

Do not install sensor cabling in the same conduit as AC power cabling.

Conductivity sensor cabling may share a common conduit with other sensors, water meter and contact set cabling.

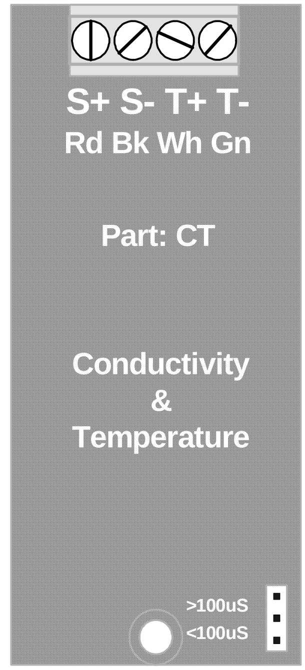




7.1.2 Configuration - Operation

Range Selection

Cooling towers – Waste Water – RO Streams:
The default range for the CT driver is >100uS. Installing a jumper on the >100uS pins does not change the default range. Use this range for conductivities from 200uS to 20,000uS.



Condensate – Low Conductivity:
Jumper the <100uS pins for conductivities in the 1 to 100uS range. Constant pressure condensate conductivities may also be measured with the single or dual B **driver using sensors without thermal compensation.**

Changing Ranges:
Turn the controller OFF before changing ranges
Controllers check range on power up, loading default
Offset and Gain on range change.

7.1.2 Configuration – Operation cont.

Diagnostics: Conductivity Input

Parameter	LCD Display	Browser	Value : Use
Sensor Location		OK	C: Installation slot. LCD displays slot letter on screen.
Input Card Type	OK	OK	Conductivity: verifies driver card type
Current State	OK	OK	Operational / Alarmed:
Displayed Value	OK	OK	1088 uS: Current measured conductivity, display user set units, 'uS' default. Displayed with user set resolution
Period Maximum		OK	1094 uS: Data from current log interval. Used to assess controls.
Period Minimum		OK	1082 uS:
Period Average		OK	1086 uS:
Sample Size		OK	426: Samples in Period Max. Min. & Average
Current Period		OK	36 minutes: Elapsed time in current log period
Log Period		OK	60 minutes: User set log period 5 to 1440 minutes
Compensation	OK	OK	Thermal Compen. / None:
Measured Level	OK	OK	184.9 mV: Raw sensor level in mV, before Gain & Offset after ID Level correction.
Gain Multiplier	OK	OK	5.6420: Calibration adjusts Gain. Displayed Value = Measured Level x Gain Multiplier + Offset Adjust Thermal Compensation is applied after Gain & Offset if selected
Default Gain	OK	OK	5.6000: Factory default Gain. Gain selected by Input Card ID
Offset Adjust	OK	OK	-35.0000: Offset. May be user adjusted.
Default Offset	OK	OK	-35.0000: Factory default Offset. Offset selected by Input Card ID
Input Card ID	OK	OK	77 mV: Drive level at >100uS range. Design level = 75mV. 1007 mV: Drive level at <100uS range. Design level = 1005mV.
Drive Level	OK		0.0 mV: Unused in CT driver.

Range	Default Gain	Calibration Gain Span	Default Offset
>100uS	5.6	2.5 to 10	-35
<100uS	0.4	.25 to .55	-10

Calibration: A calculated gain outside of the Calibration Gain Span requires a user selected Override to complete calibration.

Driver Verification Test:
Connect 1K ohm resistor to 'S+' & 'S-'. Set Range to '>100uS'. Measured Level = 187.5mV +/-5mV

7.1.2 Configuration – Operation cont.

Diagnostics: Temperature Input

Parameter	LCD Display	Browser	Value : Use
Sensor Location		OK	D: Installation slot. LCD displays slot letter on screen.
Input Card Type	OK	OK	Temperature: verifies driver card type
Current State	OK	OK	Operational / Alarmed:
Displayed Value	OK	OK	78.47 F: Current measured conductivity, display user set units, 'F'/'C' are defaults. Displayed with user set resolution. 'Metric' switch selects 'C' as default.
Period Maximum		OK	78.55 F: Data from current log interval.
Period Minimum		OK	78.30 F:
Period Average		OK	78.45 F:
Sample Size		OK	1320: Samples in Period Max. Min. & Average
Current Period		OK	37 minutes: Elapsed time in current log period
Log Period		OK	60 minutes: User set log period 5 to 1440 minutes
Compensation	OK	OK	None:
Measured Level	OK	OK	2988.1 mV: Raw sensor level in mV, before Gain & Offset. 10mV/K = 298.8K, 25.8C
Gain Multiplier	OK	OK	0.18: Gain. May be user adjusted.
Default Gain	OK	OK	0.18: Factory default Gain. Gain selected Metric switch. Metric Default Gain = 0.1
Offset Adjust	OK	OK	-461.4: Calibration adjusts Offset. Displayed Value = Measured Level x Gain Multiplier + Offset Adjust. .
Default Offset	OK	OK	-459.4: Factory default Offset. Offset selected by Input Card ID Metric Default Offset = -273
Input Card ID	OK	OK	3003 mV: Ignored by controller, card ID set by conductivity input.
Drive Level	OK		0.0 mV: Unused in CT driver.

Units	Default Gain	Calibration Offset Span	Default Offset
F	0.18	-430 to –590	-459.4
C / Metric Option Set	0.10	-253 to -293	-273.0

Calibration: A calculated offset outside of the Calibration Offset Span requires a user selected Override to complete calibration.

Driver Verification Test:
Connect 1K ohm resistor to 'T+' & 'T-'. Measured Level = 680 +/-5mV
Measured Level = 680uA thermal sensor drive x 1K ohm

7.1.3 Specifications

Range / Function		Drive
>**100uS** 100 – 10,000uS	Resolution: 1uS Accuracy: +/-5uS	75mV AC
>100uS 10,000 - 20,000uS	Tracks reduced resolution & accuracy	75mV AC
<100uS 1-100 uS	Resolution: 1uS Accuracy: +/-1uS	1005mV AC
Temperature 32 – 250F 0 – 125C	Resolution: 0.1F / 0.1C Accuracy: 1 F/C Temperature compensation of conductivity is %/Degree from 70F or 20C	680uA Constant current. 5 VDC MAX.

Notes:

1. Accuracy stated after sensor calibration.
2. Excludes errors due to extending sensor cabling.

7.1.4 Revisions

Date	Revision
5/31/07	Corrected 1.4 Sensor Wiring color coding to match corrected driver card text. Actual text on CT driver cards is correct and unchanged. Previously, text inverted WHITE & GREEN
7/2/08	Reformatted for Aegis manual

7.2 CT: Boiler Conductivity

Safety

250mV AC maximum on field wiring terminals.
24 VDC maximum on internal card surfaces.

7.2.1 Installation

Services

The B driver measures one or two conductivities.
Each of the two sensor drives may be jumper configured for boiler or condensate conductivity measurement.
Up to two dual or single 'B' drivers may be installed in an Aegis controller.

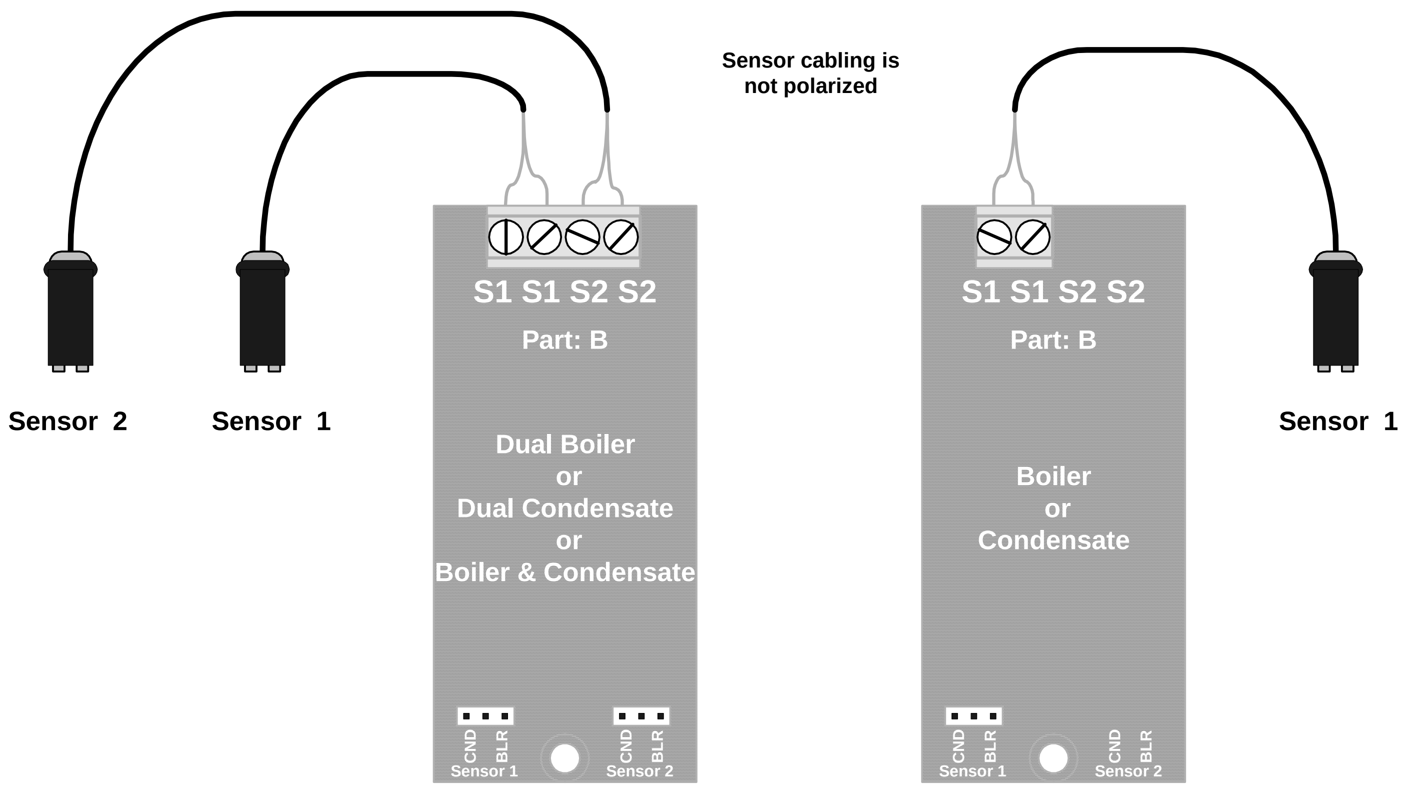
Driver Card Installation

1. Turn OFF the controller AC power
2. The single and dual B driver cards may be installed in either the Sensors 'C' & 'D' or Sensors 'E' & 'F' slot.
3. Turn ON the controller after installing the B Driver and the controller will auto-configure, displaying one or both conductivities on the LCD display and browser.

Sensor Types

Aquatrac type A261000, A261001 & A261CHP boiler-condensate sensors

Sensor Wiring



Sensor Wiring cont.

Conductivity sensor cabling may be extended up to 200ft / 60m, using single pair AWG22 / 0.25 mm^2, cable spliced to the sensor cable using wire nuts or crimped connectors located in an electrical fitting or enclosure.

Do not install sensor cabling in the same conduit as any AC power cabling, particularly cabling used to power steam rated solenoids and/or motorized boiler blowdown valves.

Conductivity sensor cabling may share a common conduit with other conductivity & fail-to-sample sensors, water meter and contact set cabling.

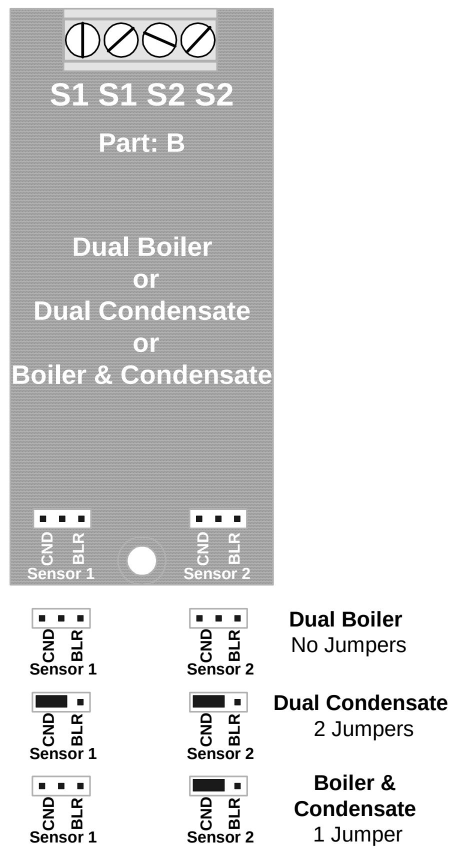
7.2.2 Configuration - Operation

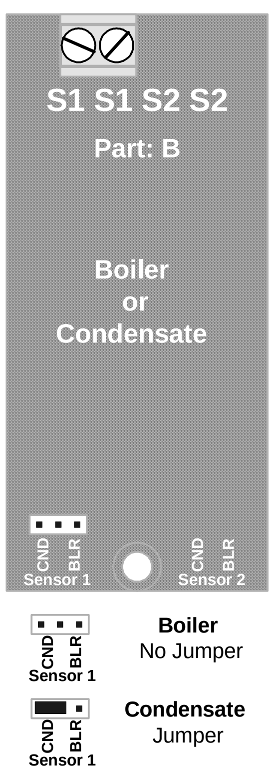
Range Selection

Boiler Blowdown:
The default range for the B driver is BLR**. Installing a jumper on the** BLR **pins does not change the default range.**
Use this range for conductivities from 200uS to 10,000uS.

Condensate – Low Conductivity:
Jumper the CND **pins for conductivities in the 1 to 200uS range.**

Changing Ranges:
Turn controller OFF before changing ranges
Controllers check range on power up, loading default
Offset and Gain on range change.





7.2.2 Configuration – Operation cont.

Diagnostics

Parameter	LCD Display	Browser	Value : Use
Sensor Location		OK	E: Installation slot. LCD displays slot letter on screen.
Input Card Type	OK	OK	Boiler Conductivity: verifies driver card type
Current State	OK	OK	Operational / Alarmed:
Displayed Value	OK	OK	3148 uS: Current measured conductivity, displays user set units, 'uS' default. Displayed with user set resolution Note: If the sensor is used for Captured Sample control of a blowdown valve, this value and all log values update at the end of the Measure period.
Period Maximum		OK	3214 uS: Data from current log interval. Used to assess controls.
Period Minimum		OK	3091 uS:
Period Average		OK	3162 uS:
Sample Size		OK	231: Samples in Period Max. Min. & Average
Current Period		OK	19 minutes: Elapsed time in current log period
Log Period		OK	60 minutes: User set log period 5 to 1440 minutes
Compensation	OK	OK	None:
Measured Level	OK	OK	1062.3 mV: Raw sensor level in mV, before Gain & Offset after ID Level correction. Displayed in real time for sensors used for Captured Sample controls.
Gain Multiplier	OK	OK	2.142: Calibration adjusts Gain. Displayed Value = Measured Level x Gain Multiplier + Offset Adjust
Default Gain	OK	OK	2.0000: Factory default Gain. Gain selected by Input Card ID
Offset Adjust	OK	OK	0.0000: Offset. May be user adjusted.
Default Offset	OK	OK	-15.0000: Factory default Offset. Offset selected by Input Card ID
Input Card ID	OK	OK	51 mV: Drive level at **BLR**, boiler range. Design level = 50mV. 206 mV: Drive level at **CND**, condensate range. Design level = 208mV.

Range	Default Gain	Calibration Gain Span	Default Offset
BLR	2.0	10 to 0.5	-15
CND	8.0	12 to 3	-90

Calibration: A calculated gain outside of the Calibration Gain Span requires a user selected Override to complete calibration. The wide span allows for the range of temperatures at the sensor.

Driver Verification Test:
Connect 1K ohm resistor to 'S1' & 'S1' or 'S2' & 'S2'.
BLR Range, Measured Level = 129mV +/-5mV. **CND** Range, Measured Level = 520mV +/-10mV

7.2.3 Specifications

Range / Function		**Drive**
BLR Boiler 100 – 10,000uS	Resolution: 1uS Accuracy: +/-25uS	50mV AC
CND Condensate 1 - 200uS	Resolution: 1uS Accuracy: +/-2uS	208mV AC

Notes:
1. Accuracy stated after sensor calibration.
2. Exclude errors due to extending sensor cabling.

7.3 OP: ORP - pH

Safety

+/-1VDC maximum on field wiring terminals.
24 VDC maximum on internal card surfaces.

7.3.1 Installation

Services

The OP driver measures ORP and pH sensors.
The driver can be configured to measure dual pH, dual ORP, pH & ORP, single pH and single ORP.
Up to two dual sensor or two single sensor 'OP' drivers may be installed in an Aegis controller.

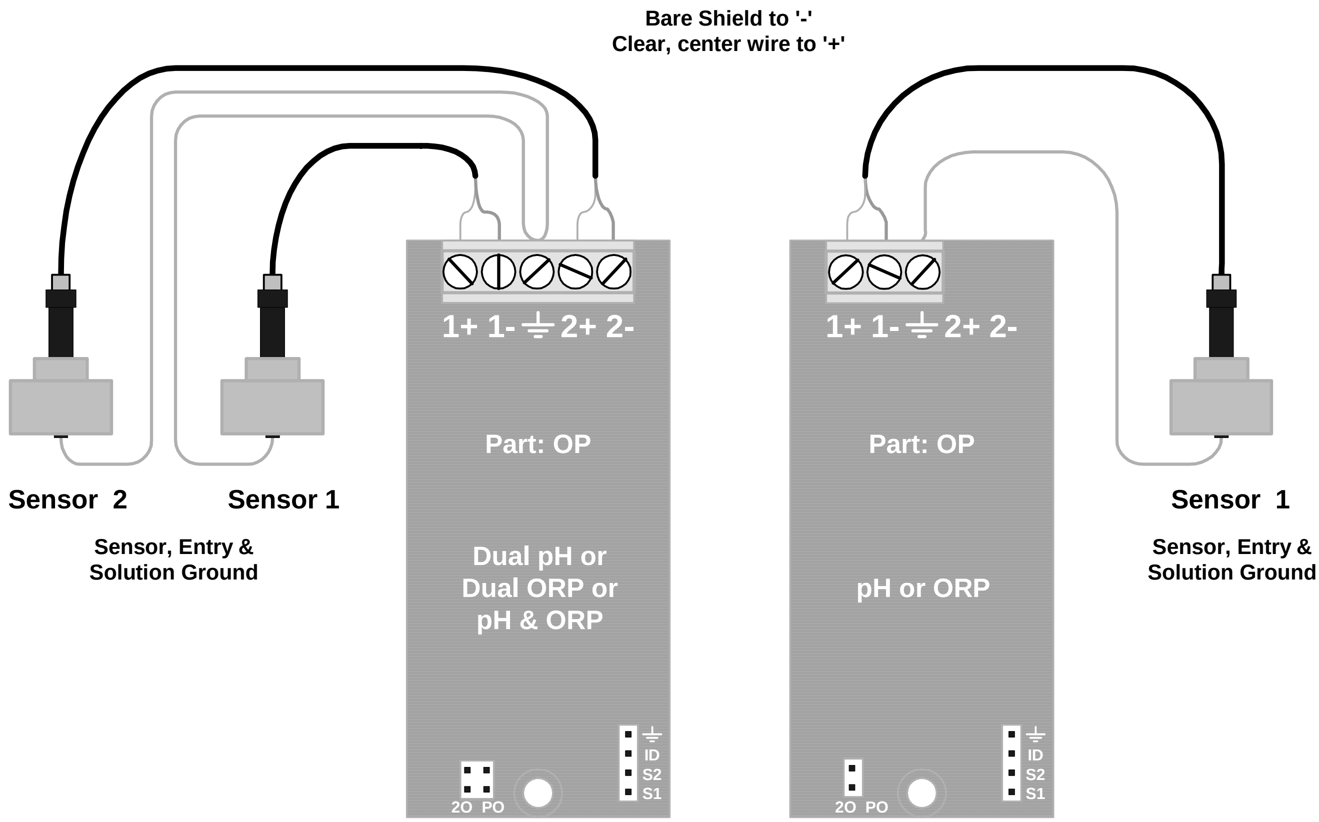
Driver Card Installation

1. Turn OFF the controller AC power
2. OP driver cards may be installed in either the Sensors 'C' & 'D' or Sensors 'E' & 'F' slot.
3. Connect the pH and/or ORP sensors to the driver field wiring terminals.
4. Turn ON the controller after installing the OP Driver and the controller will auto-configure, displaying the installed sensor or sensors on the LCD display and browser.

Sensor Types

Aquatrac pH types A261100, A261102, SXT-HPP and ORP types A261105, ORP-FF, SXT-HPO
Generally, all ORP and pH sensors with a single coaxial cable may be used with the OP drivers.

Sensor Wiring



Sensor Wiring cont.

ORP sensor cabling may be extended up to 200ft / 60m, using single pair AWG22 / 0.25 mm^2, cable spliced to the sensor cable using wire nuts or crimped connectors located in an electrical fitting or enclosure. Higher internal impedance pH sensor's cabling cannot be extended more than 25ft, 10m.

Do not install sensor cabling in the same conduit as AC power cabling.

ORP, pH sensor cabling may share a common conduit with other sensors, water meter and contact set cabling. Solution grounds are single conductor AWG18-22 / 0.25-0.75 mm^2.

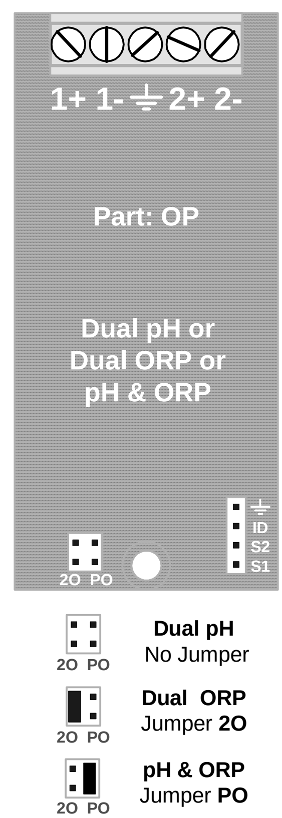
Warning 1: Do not install pH sensors without installing and connecting a solution ground. Unstable, drifting pHs will occur if the solution ground is disconnected.

Warning 2:
Turn OFF the controller before connecting or disconnecting pH and ORP sensors.

7.3.2 Configuration - Operation

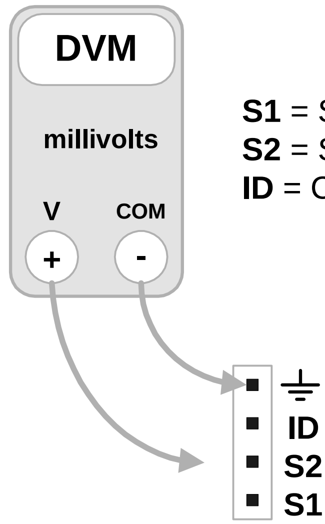
Sensor Set Selection

Changing Sensor Set:
Turn controller OFF before changing sensor selection jumpers.
Controllers check selection jumpers on power up, loading default Offset and Gain on range change.



7.3.2 Configuration – Operation cont.

Driver Test Header



S1 = Sensor 1 mV x -1
S2 = Sensor 2 mV x -1
ID = Card ID Level

ID = Card ID Level

Dual pH	1150
Dual ORP	1345
pH & ORP	1450
Single pH	1050
Single ORP	1250

7.3.2 Configuration – Operation cont.

Diagnostics: pH Input

Parameter	LCD Display	Browser	Value : Use
Sensor Location		OK	A: Installation slot. LCD displays slot letter on screen.
Input Card Type	OK	OK	pH Sensor: verifies driver card type
Current State	OK	OK	Operational / Alarmed:
Displayed Value	OK	OK	8.12 pH: Current measured pH, display user set units, 'pH' default. Displayed with user set resolution
Period Maximum		OK	8.15 pH: Data from current log interval. Used to assess controls.
Period Minimum		OK	8.05 pH:
Period Average		OK	8.10 pH:
Sample Size		OK	122: Samples in Period Max. Min. & Average
Current Period		OK	18 minutes: Elapsed time in current log period
Log Period		OK	15 minutes: User set log period 5 to 1440 minutes
Compensation	OK	OK	None:
Measured Level	OK	OK	62.3 mV: Raw sensor level in mV, before Gain & Offset after ID Level correction.
Gain Multiplier	OK	OK	0.0170: User set Gain
Default Gain	OK	OK	0.0170: Factory default Gain, 59mV/pH Gain selected by Input Card ID
Offset Adjust	OK	OK	7.2361: Offset. Calibration adjusts Offset. Displayed Value = Measured Level x Gain Multiplier + Offset Adjust
Default Offset	OK	OK	7.0000: Factory default Offset. Offset selected by Input Card ID
Input Card ID	OK	OK	1147 mV: Dual pH Design level = 1150 mV. Single pH Design level = 1050 mV PH – ORP Design level = 1450 mV

Sensor Type	Default Gain	Calibration Offset Span	Default Offset
PH	0.017	6 - 8	7

Calibration: A calculated offset outside of the Calibration Offset Span requires a user selected Override to complete calibration.

Driver Verification Test:
Connect a pH sensor, center conductor to 1+ and shield to 1-. Immerse sensor into pH10 buffer and connect a solution ground wire with an exposed wire end immersed in the buffer. Measured Level = 170mV +/-25mV

7.3.2 Configuration – Operation cont.

Diagnostics: ORP Input

Parameter	LCD Display	Browser	Value : Use
Sensor Location		OK	B: Installation slot. LCD displays slot letter on screen.
Input Card Type	OK	OK	ORP Sensor: verifies driver card type
Current State	OK	OK	Operational / Alarmed:
Displayed Value	OK	OK	321 mV: Current measured ORP, display user set units, 'mV' default. Displayed with user set resolution
Period Maximum		OK	340 pH: Data from current log interval. Used to assess controls.
Period Minimum		OK	306 pH:
Period Average		OK	318 pH:
Sample Size		OK	411: Samples in Period Max. Min. & Average
Current Period		OK	38 minutes: Elapsed time in current log period
Log Period		OK	120 minutes: User set log period 5 to 1440 minutes
Compensation	OK	OK	None:
Measured Level	OK	OK	307.4 mV: Raw sensor level in mV, before Gain & Offset after ID Level correction.
Gain Multiplier	OK	OK	-1.0000: User set Gain
Default Gain	OK	OK	-1.0000: Factory default Gain, Gain selected by Input Card ID
Offset Adjust	OK	OK	13.612: Offset. Calibration adjusts Offset. Displayed Value = Measured Level x Gain Multiplier + Offset Adjust
Default Offset	OK	OK	0.0000: Factory default Offset. Offset selected by Input Card ID
Input Card ID	OK	OK	1145 mV: Dual ORP Design level = 1344 mV. Single ORP Design level = 1250 mV PH – ORP Design level = 1450 mV

Sensor Type	Default Gain	Calibration Offset Span	Default Offset
ORP	-1	+50 to -50	0

Calibration: A calculated offset outside of the Calibration Offset Span requires a user selected Override to complete calibration.

7.3.3 Specifications

Function		Notes
Input Range	+/- 1000mV 0-14 pH	
Resolution	ORP: 0.1mV PH: 0.01 pH	
Accuracy	+/- 0.1mV +/- 0.02pH	Requires installed solution ground for each measured sensor.
Input Impedance	> 500 MOhm	Fully differential. 10M ohm power OFF input resistance

Notes:
Accuracy stated after sensor calibration.

7.4 CI: Dual 4-20mA Current Input

Safety
30 VDC maximum on field wiring terminals.
30 VDC maximum on internal card surfaces.

7.4.1 Installation

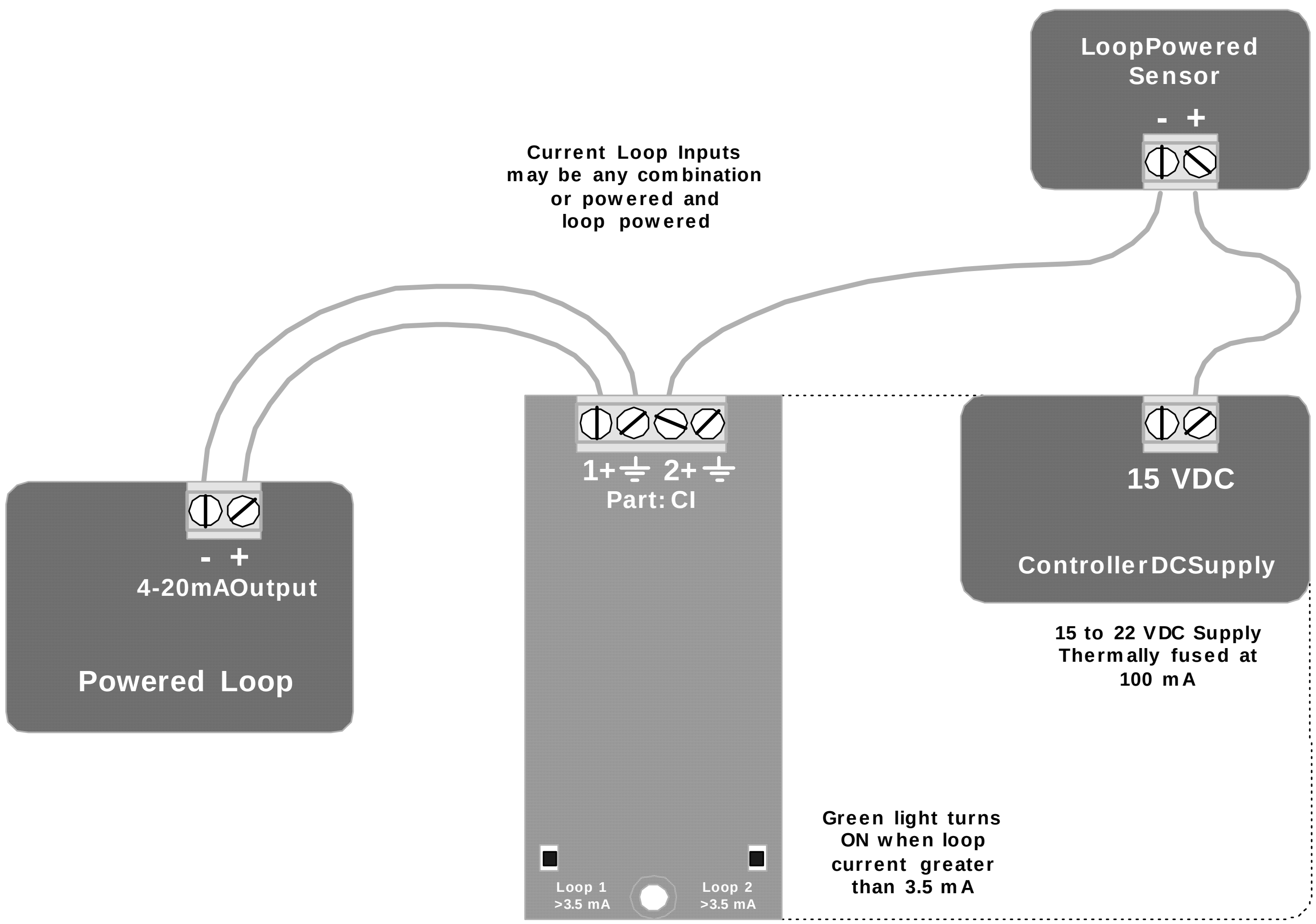
Services

The CI driver measures two 4-20mA current loops.
The CI driver terminates each current loop with 50 ohms, referenced to electrical ground.
Each 4-20mA input is polarity and thermally protected.
Up to two CI drivers may be installed in an Aegis controller in addition to the fixed 4-20mA input at controller input 'G'.

Card Installation

1. Turn OFF the controller AC power
2. CI driver cards may be installed in either the Sensors 'C' & 'D' or Sensors 'E' & 'F' slot.
3. Turn ON the controller after installing the CI Driver and the controller will auto-configure, displaying both inputs as millivolt levels, 200mV=4mA to 1000mV=20mA.

Driver Wiring



7.4.1 Installation cont.

Driver Wiring

AWG22 / 0.25 mm^2, current loop cabling may be extended several hundred feet or meters without causing measurement errors. The maximum cable length is determined by the open loop voltage and the cable gauge.

Do not install current loop cabling in the same conduit as AC power cabling.

Current loop cabling may share a common conduit with other sensors, water meter and contact set cabling.

7.4.2 Configuration - Operation

Diagnostics

Parameter	LCD Display	Browser	Value : Use
Sensor Location		OK	C: Installation slot. LCD displays slot letter on screen.
Input Card Type	OK	OK	4-20mA Input: verifies driver card type
Current State	OK	OK	Operational / Alarmed:
Displayed Value	OK	OK	1836 gpm: Current measured conductivity, display user set units, '---' default. Displayed with user set resolution
Period Maximum		OK	1920 gpm: Data from current log interval. Used to assess controls.
Period Minimum		OK	1110 gpm:
Period Average		OK	1412 gpm:
Sample Size		OK	1110: Samples in Period Max. Min. & Average
Current Period		OK	46 minutes: Elapsed time in current log period
Log Period		OK	60 minutes: User set log period 5 to 1440 minutes
Compensation	OK	OK	None / Rate-to-Volume:
Measured Level	OK	OK	787.5 mV: Raw sensor level in mV, before Gain & Offset after ID Level correction.
Current Loop		OK	15.75 mA: Calculated loop current. Input 'G' terminated by 100 ohms otherwise terminated with 49.9 ohms.
Gain Multiplier	OK	OK	3.1250: Calibration adjusts Gain. Displayed Value = Measured Level x Gain Multiplier + Offset Adjust
Default Gain	OK	OK	1.0000: Factory default Gain. Gain selected by Input Card ID
Offset Adjust	OK	OK	-625: Offset. May be user adjusted.
Default Offset	OK	OK	0.0000: Factory default Offset. Offset selected by Input Card ID
Input Card ID	OK	OK	2218 mV: Design level = 2216mV.

Driver Verification Test:
Connect a 2K ohm (Optionally use 2 x 1K, 5%, 1/4W) resistor between controller +15 VDC terminal and CI Driver terminal **1+.**
Measured Level will be nominally 500mV if the +15VDC terminal is @ 20VDC.
Actual Level varies with the unregulated +15VDC supply and equals: 49.9 x (VDC / (2000 + 49.9)) , where the controller terminate the loop with 49.9 ohms and a 2,000 ohm test resistor is installed.

7.4.2 Configuration - Operation cont.

Calibration

Current loops where 4mA is NOT equal to zero, GPM, uS… require two point calibration to convert the measured current into end user units.

The current loop may be calibrated using either the Keypad or the Browser, by either calculating the Offset & Gain or driving the current loop between two values.

Two Point Calibration.

1. Configure the device or sensor controlling the current loop to operate at 4mA.
2. Select Sensors / Calibrate and @ 'Enter first value' key the 4mA level in site units. For example if your current loop was spanned 0-2500GPM = 4-20mA, you would key 0 & Enter
3. Configure the device or sensor controlling the current loop to operate at 20mA.
4. Key the 20mA level @ the 'Enter second Value' prompt. In our example you would key 2500 & Enter
5. The controller will then calculate the Offset & Gain required to convert the measured current to user units. In our 0-2500GPM example Gain = 3.125 & Offset = 625.

Any two loop currents may be used to calibrate. The previous 4mA & 20mA example is the optimum. Accuracy improves as the difference between the two calibration currents increase.

Calculating Offset & Gain

1. The input Offset Adjust and Gain Multiplier may be manually set using Sensors / Configuration.
2. This method to convert a measured current to a user value may be used if it's not easy to drive the current loop between 4 & 20 mA.

At 4mA the 50ohm loop terminating resistor measures 200mV (50 x 0.004).
At 20mA the 50ohm loop terminating resistor measures 1000mV (50 x 0.020).
As the current loop varies from 4-20mA, the controller measures a mV change from 200 to 1000; an 800mV change.

If the site 4mA_Level & 20mA_Level are known.
Gain Multiplier = (20mA_Level – 4mA_Level) / 800
Offset Adjust = -200 x Gain Multiplier

Example: 4mA_Level = 0 GPM & 20mA_Level = 2500 GPM
Gain Multiplier = 2500 /800 = 3.125
Offset Adjust = -200 x 3.125 = 625

Check: At 4mA we'll measure 200mV and display 200 x 3.125 – 625 = 0 GPM
At 20mA we'll measure 1000mV and display 1000 x 3.125 – 625 = 2500 GPM

7.4.3 Specifications

Function		**Notes**
Resolution	0.0125% of span, 2uA	Most current loop sources are 10 bit , resolution; typically 0.1% of span. In this case, the source of the current loop or loop powered sensor constrains overall accuracy and resolution.
Accuracy	+/- .05% of span	
Max Input Voltage	30VDC	Input is polarity protected to 50VDC and thermally fused at 100mA. Common, electrical ground inputs are not fused.
Terminated Loop Indicator	Green LED ON at loop currents greater than 3.5mA	Visual indication of correct loop wiring polarity and active loop power.

Notes:

1. Accuracy stated after calibration.
2. Resolution Example: If 4-20mA represents 0-2500GPM and the current transmitter has 10 bit resolution, then flow rate would change in increments of 2.5 GPM.

7.5 IO: 4-20mA Output

Safety
30 VDC maximum on field wiring terminals.
24 VDC maximum on internal card surfaces.

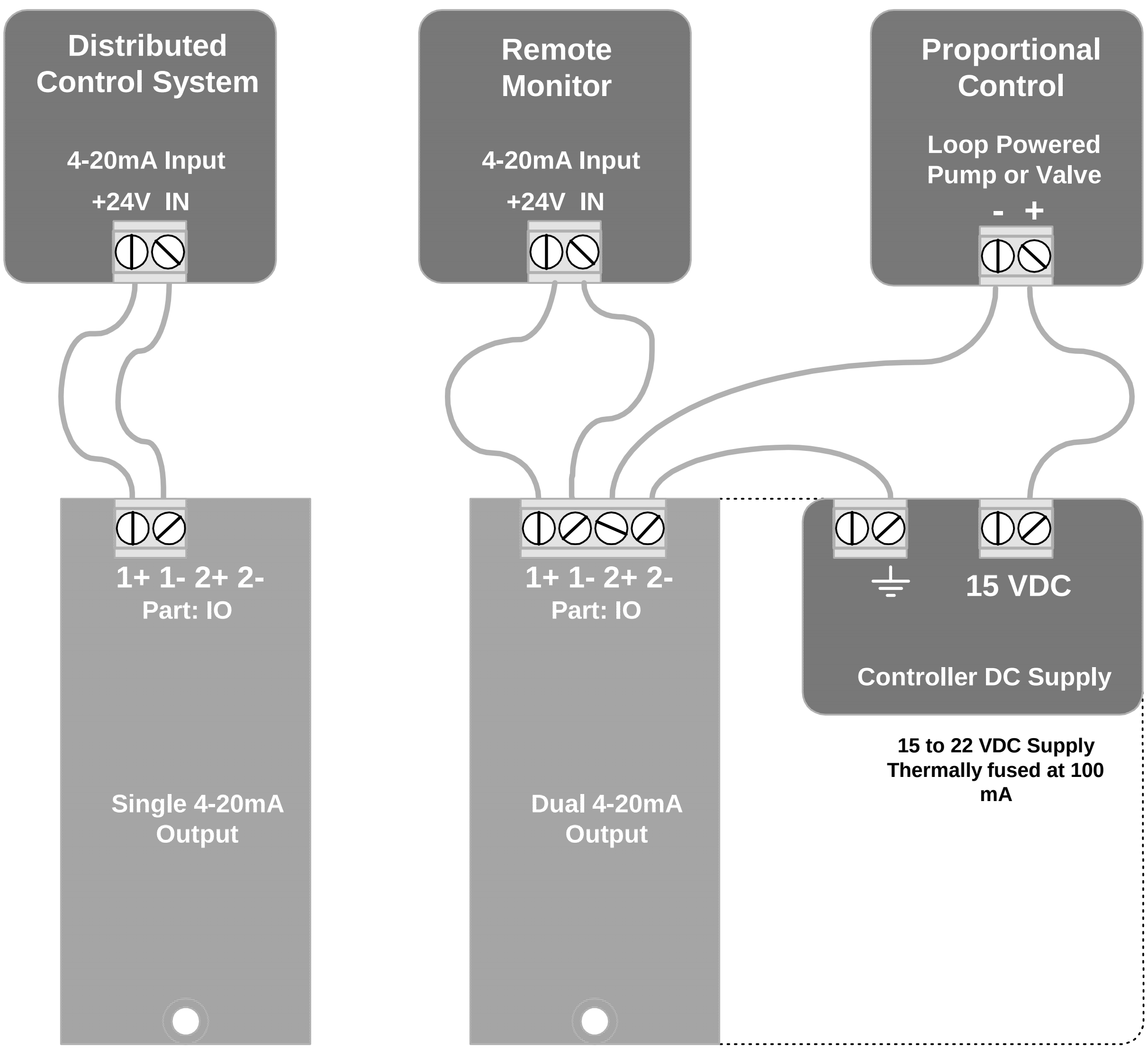
7.5.1 Installation

Services
The IO driver provides one or two, DC isolated, loop powered 4-20mA outputs.
Up to two dual, 4-20mA output 'IO' drivers may be installed in an Aegis controller.
The current output level 0% to 100% is logged by the controller.

Card Installation

1. Turn OFF the controller AC power
2. IO driver cards may be installed in either the Sensors 'C' & 'D' or Sensors 'E' & 'F' slot.
3. Turn ON the controller after installing the IO Driver and the controller will auto-configure, displaying the current output, on the LCD display and browser.

Current Loop Wiring



7.5.1 Installation cont.

Current Loop Wiring

AWG22 / 0.25 mm^2, current loop cabling may be extended several hundred feet or meters without causing measurement errors. The maximum cable length is determined by the open loop voltage and the cable gauge.

Do not install current loop cabling in the same conduit as AC power cabling.

Current loop cabling may share a common conduit with other sensors, water meter and contact set cabling.

7.5.2 Configuration - Operation

Diagnostics

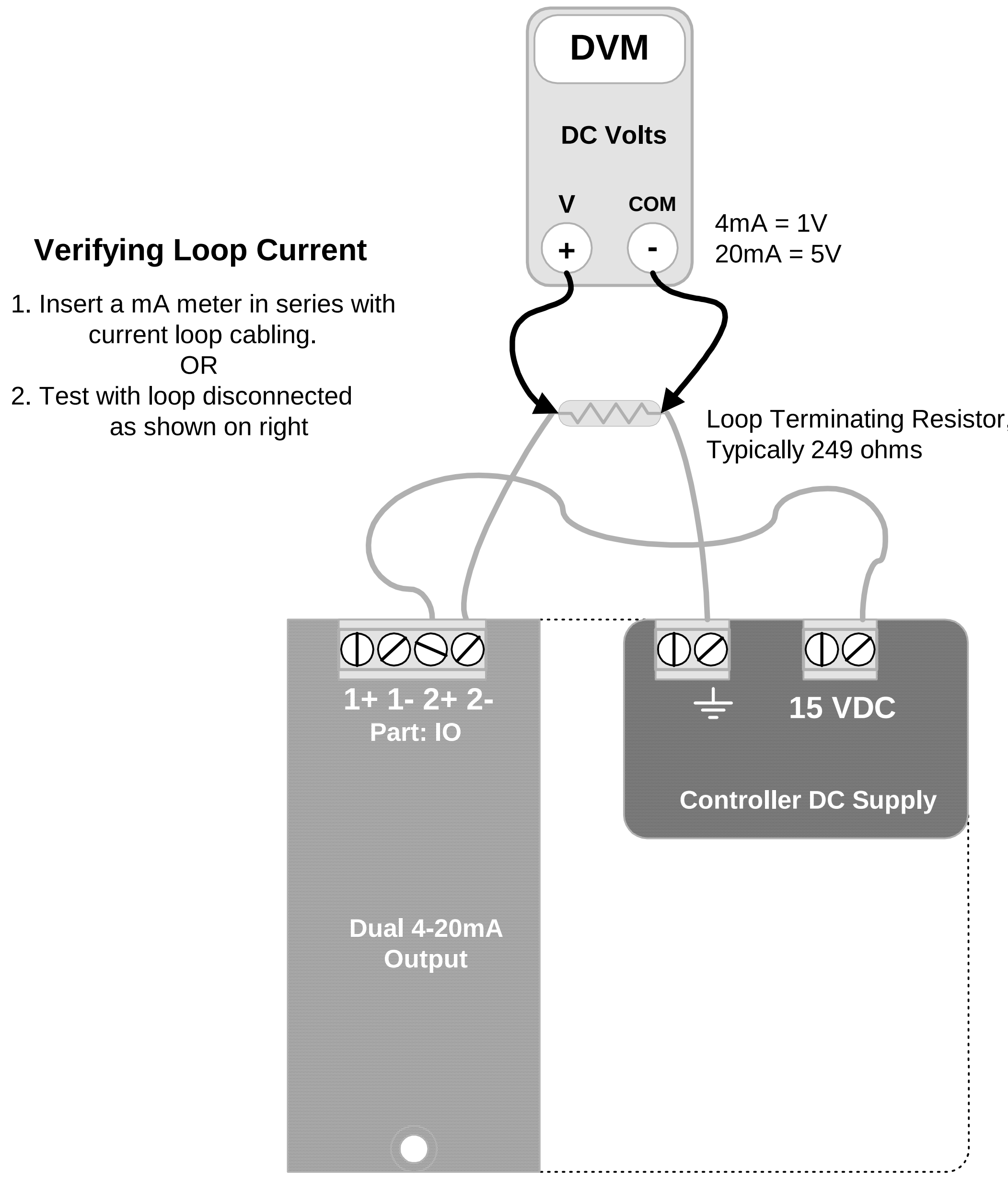
Parameter	LCD Display	Browser	Value : Use
Sensor Location		OK	Installation slot. LCD displays slot letter on screen.
Input Card Type	OK	OK	4-20mA Output: verifies driver card type
Status	OK	OK	Manual / Auto Loop open alarm
Displayed Value	OK	OK	12.0 mA & 50.0%: Displays both current mA level & % of span Displayed with user set resolution
Period Maximum		OK	52.6% Data from current log interval. Used to assess controls.
Period Minimum		OK	48.1%:
Period Average		OK	50.2%:
Sample Size		OK	48: Samples in Period Max. Min. & Average
Current Period		OK	21 minutes: Elapsed time in current log period
Log Period		OK	60 minutes: User set log period 5 to 1440 minutes
Trim Span	OK	OK	950: 20mA span. Keypad adjustable
Trim Zero	OK	OK	9: 4mA zero. Keypad adjustable
Input Card ID	OK	OK	2467 mV: Design level = 2460mV.

Manual - Auto

A 4-20mA output may be switched from Auto control to Manual.
Manual mode allows the user to set an output from 0% to 100% to base feed, set up feed rates and verify monitoring inputs.
On return to Auto the 4-20mA span and controlling sensor or relay are restored, unchanged.

7.5.2 Configuration - Operation cont.

Hardware Calibration



Hardware Calibration is used to compensate for component level errors.
It's only available via the keypad and forces the current loop to 20mA to adjust SPAN and to 4mA to adjust ZERO. Trim Zero default = 9 Trim Span default = 950

7.5.3 Specifications

Function		Notes
Resolution & Accuracy	0.1% & +/- 0.15%	
DC Isolated	Terminals 1+ & 1- DC isolated from 2+ & 2-	Outputs DC isolated from electrical ground – controller common.
Loop Polarity	Auto-correcting	Driver input terminals are not sensitive to polarity.
Max Loop Voltage	30VDC.	Current loops powered by the controller unregulated 15VDC supply do not exceed 24VDC.
Minimum Loop Termination	10 ohms.	LMI solenoid drive pump, proportional control input = 22 ohms

7.6 CR: Corrosion Rate

Safety
100mV DC maximum on field wiring terminals.
24 VDC maximum on internal card surfaces.

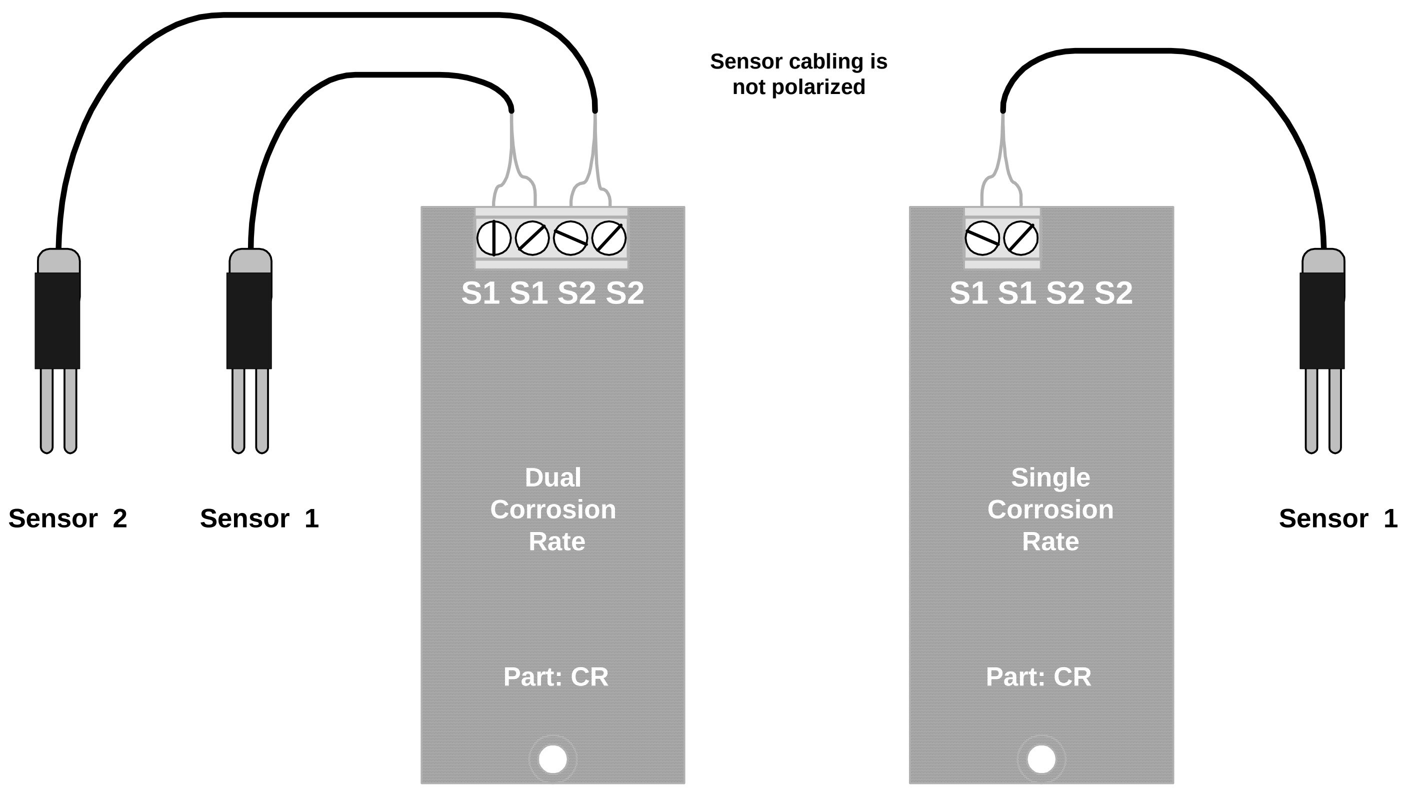
7.6.1 Installation

Services
The CR driver measures one or two corrosion rates using Linear Polarization Resistance.
Dual CR drivers allow two alloys, copper & steel for example, to be monitored concurrently..
Up to two dual and one single 'CR' drivers may be installed in an Aegis controller.

Card Installation
1. Turn OFF the controller AC power
2. The single and dual CR driver cards may be installed in either the Sensors 'C' & 'D' or Sensors 'E' & 'F' slot.
3. Turn ON the controller after installing the CR Driver and the controller will auto-configure, displaying one or both corrosion rates on the LCD display and browser.

Sensor Types
Aquatrac type CRS-SEN corrosion rate sensors.
Alloy sensor sets available in steel, copper, admiralty and cupro-nickel

Sensor Wiring



7.6.1 Installation cont.

Sensor Wiring

Corrosion rate sensor cabling may be extended up to 200ft / 60m, using single pair AWG22 / 0.25 mm^2, cable spliced to the sensor cable using wire nuts or crimped connectors located in an electrical fitting or enclosure.

Do not install sensor cabling in the same conduit as any AC power cabling.

Corrosion Rate sensor cabling may share a common conduit with other sensors, water meter and contact set cabling.

7.6.2 Configuration - Operation

Setup-Calibration

Alloy Number:
The Alloy Number is used to convert the Linear Polarization Current to a rate of metal loss in mils/year.
The default Alloy Number is 1.000, Carbon Steel.
Common alloy numbers are Copper @ 2.00, 90/10 Cupro-Nickel @ 1.80, Zinc @ 1.29, Admiralty @ 1.67

Conductivity Sensor:
If the controller includes a conductivity sensor installed in the same sample stream at the corrosion rate sensor, the corrosion rate measurement may be corrected for conductivity.
Conductivity correction has little effect at 1000uS with correction increasing as conductivity falls.
At low conductivities, LPR faults and alarms.

Calibration:
The CR driver can operate without calibration with nominally 0.05 mpy of static error caused by component offsets in the driver card.
If you disconnect the sensor and calibrate for 0 mpy, the controller will correct the Offset for the static error.
This is a one-time calibration unless you move the CR driver to another controller slot. A new slot, resets the offset calibration.

7.6.2 Configuration - Operation cont.

Diagnostics

Parameter	LCD Display	Browser	Value : Use
Sensor Location		OK	E: Installation slot. LCD displays slot letter on screen.
Input Card Type	OK	OK	Corrosion Rate: verifies driver card type
Current State	OK	OK	Operational / Alarmed:
Displayed Value	OK	OK	1.23 mpy: Current measured corrosion rate, Displayed with user set resolution Updates every 128 seconds
Period Maximum		OK	1.28 mpy: Data from current log interval.
Period Minimum		OK	1.21 mpy:
Period Average		OK	1.22 mpy:
Sample Size		OK	106: Samples in Period Max. Min. & Average
Current Period		OK	26 minutes: Elapsed time in current log period
Log Period		OK	60 minutes: User set log period 5 to 1440 minutes
Compensation	OK	OK	Corrosion Rate: Sequences through six steps, repeating every 128 seconds
Anodic Level	OK	OK	52.1 mV: Anodic & Cathodic levels should be opposite in sign and nominally the same value.
Cathodic Level	OK	OK	-48.6 mV:
Pitting Level	OK	OK	1.2 mV: Pitting should always be less than either Anodic or Cathodic. Pitting alarms are blocked for corrosion rates less than 2mpy. **A Pitting level higher than the Anodic or Cathodic level is an invalid corrosion rate measurement.** **Replace pitted sensor tips.**
Measured Level	OK	OK	6.8 mV: Raw sensor level in mV Displayed in real time as the CR driver sequences.
Gain Multiplier	OK	OK	1.0000: User set Gain.
Default Gain	OK	OK	1.0000: Factory default Gain. Gain selected by Input Card ID
Offset Adjust	OK	OK	-0.532: Offset. Calibration adjusts Offset for hardware error.
Default Offset	OK	OK	0.0000: Factory default Offset. Offset selected by Input Card ID
Input Card ID	OK	OK	1614 mV: Dual Design level = 1611mV. Single Design level = 1548mV
Drive Level	OK	OK	1209.9 mV: Offset correction allied to measured values. Inserted by driver card optical isolation.

Driver Verification Test:
Connect 10K ohm resistor to ‘S1’ & ‘S1‘ or ‘S2’ & ‘S2’.
Configure with Alloy Number =1.000 & no conductivity sensor.
Controller will display nominally 0.5mpy.
Anodic & Cathodic Levels will be nominally +/-50mV with pitting level +/-10mV.

7.6.3 Specifications

Function		Notes
Resolution	0.1mpy	Linear Polarization Resistance, LPR is applicable where general corrosion is the dominant corrosion mode. LPR is useful in measuring relative corrosion rates, process upsets and the immediate effect of changing treatment programs or operating conditions. **LPR is not an applicable technique for processes where pitting is the dominant corrosion mechanism.** Aluminum alloys and Stainless steels in cooling water and waste water stream usually pit.
Sensor Drive	DC Isolated.	Each sensor drive is separately electrically isolated from controller common and electrical ground.
Uncalibrated Error	0.05 mpy Nominal	Calibration with sensor disconnected removes The effect of Uncalibrated Error

Notes:

1. Accuracy with respect to weight loss measurements is typically 50% to 200%.
2. The first valid corrosion rate measurement occurs 4 minutes after Power ON and is updated every 2 minutes thereafter.

CR Driver Revision Log		
01/01/04 Initial release	Version 037 CR Driver cards	16 Second measurement cycle
05/05/05	Version 054 CR Driver cards	128 Second measurement cycle
09/05/05	Rate with 10K test resistor now 0.5mpy was 5mpy. Uncalibrated error reduced from 0.5mpy to 0.05mpy	Requires controller firmware Version T095 and later.
07/02/08	Reformatted for Aegis controllers	

7.7 PT: pH - Temperature

Safety
+/-1VDC maximum on field wiring terminals.
24 VDC maximum on internal card surfaces.

7.7.1 Installation

Services

The **PT**, pH-Temperature driver measures a pH sensor and a temperature using a platinum RTD.

The driver can be jumper configured to measure either 100 ohm or 1000 ohm RTDs.
The controller detects the location of the RTD selection jumper on power up and auto-configures.

Up to two '**PT**' drivers may be installed in an Aegis controller.

Although most installations will use the **PT** driver temperature input to thermally compensate the pH input, the pH and temperature inputs of the **PT** driver may be also used independently to control pumps and solenoids.

Temperature Compensation of pH

Cooling Tower Applications

The amount of pH variation with temperature increases as the pH increases above pH 7 or decreases below pH 7. Cooling towers operating around pH 8 and over a narrow temperature range are seldom temperature compensated. The pH error due to temperature in cooling towers is nominally 0.1pH which does not justify the cost and complexity of pH temperature compensation.

Process Applications

Temperature changes the mV/pH response of the pH sensor. The following table shows how the response of the pH sensor varies with temperature and the error that temperature compensation of pH corrects.

The 8pH column is included to demonstrate the minimal effect temperature has in the 50-90F typical cooling tower application range.

Temperature	millivolts/pH	mV@ 4pH pH error	mV @ 7pH pH error	mV @ 8pH pH error	mV @ 10pH pH error
0C or 32F	-54.2	162.6mV 0.25pH	0mV 0pH	-54.2mV 0.08pH	-162.6mV 0.25pH
25C or 77F	-59.16	177.5mV	0mV	-59.2mV	-177.5mV
100C or 212F	-74.04	222.12 0.79pH	0mV 0pH	-74.04mV 0.25pH	-222.12 0.79pH

The mV/pH value is the controller pH sensor **GAIN**.
The controller's default pH sensor 25C **GAIN** is 0.017, nominally 1 / 59.16 mV/pH

When the pH sensor **Compensation** is set to **Temperature**, the controller adjusts the pH sensor **GAIN** based on the value measured at the selected Temperature sensor.

7.7.1 Installation cont.

Controller Services

The controller provides services to calibrate the RTD temperature and to warn you of wiring & operational problems. The controller limits the range of temperatures that can be used for pH temperature compensation to limit operating problems on a defective or mis-calibrated RTD sensor.

1. Temperature compensation of pH can only be applied to pH sensors connected to pH input cards. 4-20mA inputs representing pH cannot be thermally compensated since these sensors are usually compensated at the pH to 4-20mA converter.

2. Compensating temperatures are only applied in the range of 0-100C, 0-212F. Out of range temperatures are not used for compensation. No thermal compensation of pH occurs. Set the **HIGH** & **LOW** alarms on the compensating thermal sensor to detect this fault.

3. Any temperature sensor, including the RTD sensor connected to the PT Driver card may be used to temperature compensate a pH sensor.

4. RTD calibration is limited to +/-20 degrees before a calibration error occurs. The warning may be overridden by the user.

5. The default RTD is 0.00385 ohm/ohm/C where the default GAIN = 1/0.00385 = 259.74. If you are using and RTD with a response other than 0.00385, use **SENSOR / CONFIGURE** to set the correct **GAIN**.

6. Disconnected RDT sensors will display –50C or –50F. When the controller measures an RTD voltage of less than 1000mV, it sets the RTD temperature to –50C or -50F.

7. When you select **SYSTEM / CONFIGURE / Metric Units**, the controller displays RTD temperatures in degrees C independent of the user set units for temperature.

8. Temperature compensation of a pH sensor can also be configured and monitored using the keypad and controller LCD display

Card Installation

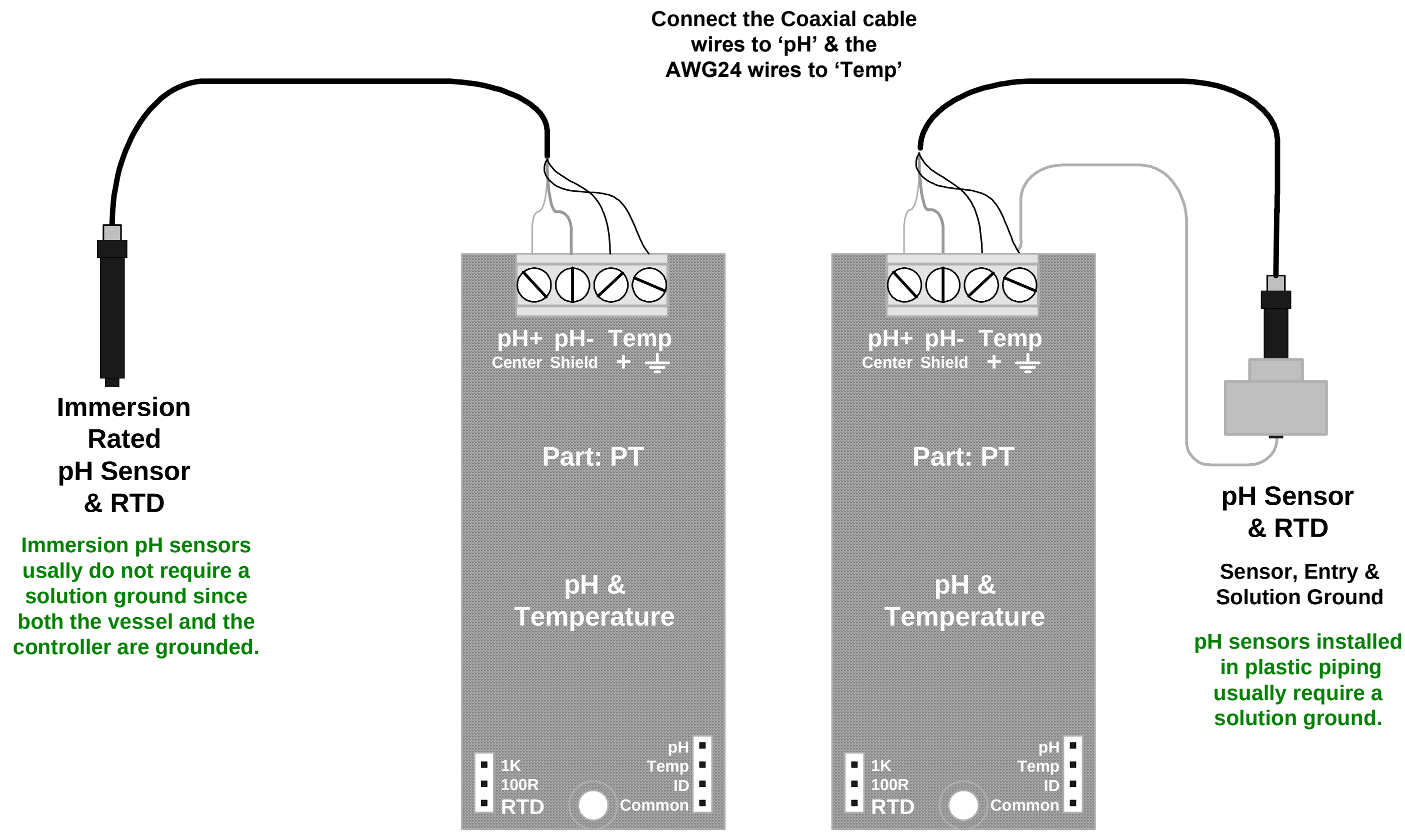
1. Turn OFF the controller AC power
2. **PT** driver cards may be installed in either the Sensors 'C' & 'D' or Sensors 'E' & 'F' slot.
3. Connect the pH and RTD sensors to the driver field wiring terminals.
4. Set the **PT** driver jumper to match the pH sensor RTD value, either 100 ohms or 1000 ohms. If you don't know the RTD value, measure the resistance between the two AWG24 sensor temperature wires.
5. Turn ON the controller after installing the **PT** Driver and the controller will auto-configure, displaying the installed sensor or sensors on the LCD display and browser.

Sensor Part Numbers

Aquatrac immersion rated pH sensor part numbers A261107, A261108 and A261109 include a thermal compensation RTD,
Generally, any pH sensor with a single coaxial cable and a 2 wire 100 ohm or 1000 ohm RTD may be used with the PT drivers.

7.7.1 Installation cont.

Sensor Wiring



At temperatures below 75F / 25C, higher internal pH impedance limits a pH sensor's cabling to nominally 25ft or 10m.
At temperatures above 100F /40C in conductive process streams, pH sensor cabling may be extended to typically 50ft, 20m without using a sensor amplifier.

Do not install pH sensor cabling in the same conduit as AC power cabling.

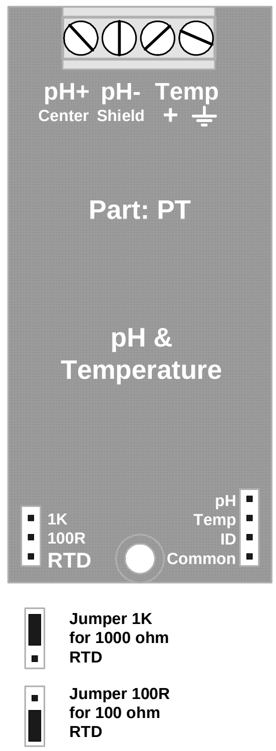
pH sensor cabling may share a common conduit with other sensors, water meter and contact set cabling.
Solution grounds are single conductor AWG18-22 / 0.25-0.75 mm^2.

Warning:
Turn OFF the controller before connecting or disconnecting pH sensors & selecting RTD.

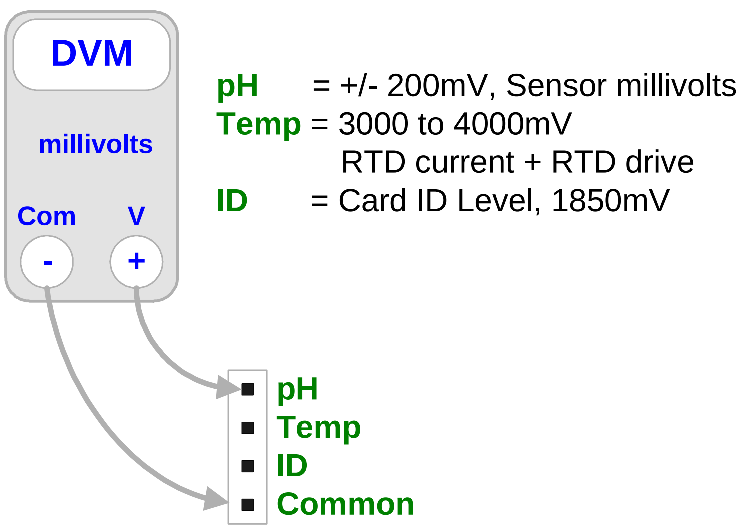
7.7.2 Configuration - Operation

RTD Selection

Changing the Selected RTD Set:
Turn controller OFF before changing the RTD selection jumper.
Controllers check the RTD selection jumper on power up, auto-configuring the temperature measurement.



Driver Test Header



7.7.3 Diagnostics pH Input

Parameter	LCD Display	Browser	Value : Use
Sensor Location		OK	A: Installation slot. LCD displays slot letter on screen.
Input Card Type	OK	OK	pH Sensor: verifies driver card type
Current State	OK	OK	Operational / Alarmed:
Displayed Value	OK	OK	8.12 pH: Current measured pH, display user set units, 'pH' default. Displayed with user set resolution
Period Maximum		OK	8.15 pH: Data from current log interval. Used to assess controls.
Period Minimum		OK	8.05 pH:
Period Average		OK	8.10 pH:
Sample Size		OK	122: Samples in Period Max. Min. & Average
Current Period		OK	18 minutes: Elapsed time in current log period
Log Period		OK	15 minutes: User set log period 5 to 1440 minutes
Compensation	OK	OK	None or Thermal Compen.
Measured Level	OK	OK	62.3 mV: Raw sensor level in mV, before Gain & Offset after ID Level correction.
Gain Multiplier	OK	OK	0.0170: User set Gain
Default Gain	OK	OK	0.0170: Factory default Gain, 59mV/pH Gain selected by Input Card ID
Offset Adjust	OK	OK	7.2361: Offset. Calibration adjusts Offset. Displayed Value = Measured Level x Gain Multiplier + Offset Adjust
Default Offset	OK	OK	7.0000: Factory default Offset. Offset selected by Input Card ID
Input Card ID	OK	OK	1854 mV: PT driver Design level = 1850 mV. **Note:** The ID level identifies this pH input as a PT driver. pH-ORP driver only cards have lower Input Card IDs

Sensor Type	Default Gain	Calibration Offset Span	Default Offset
PH	0.017	6 – 8	7

Calibration: A calculated offset outside of the Calibration Offset Span requires a user selected Override to complete calibration.

Driver Verification Test:
Connect a pH sensor, center conductor to pH+ and shield to pH-. Immerse sensor into pH10 buffer and connect a solution ground wire with an exposed wire end immersed in the buffer.
Measured Level = +170mV +/-25mV

7.7.3 Diagnostics: Temperature Input

Parameter	LCD Display	Browser	Value : Use
Sensor Location		OK	B: Installation slot. LCD displays slot letter on screen.
Input Card Type	OK	OK	100 ohm RTD OR 1000 ohm RTD : verifies driver card type
Current State	OK	OK	Operational / Alarmed:
Displayed Value	OK	OK	128F: Current measured temperature, display user set units, 'F' OR 'C" if 'Metric' selected default. Displayed with user set resolution
Period Maximum		OK	132 F: Data from current log interval. Used to assess controls.
Period Minimum		OK	126 F:
Period Average		OK	129 F:
Sample Size		OK	186: Samples in Period Max. Min. & Average
Current Period		OK	38 minutes: Elapsed time in current log period
Log Period		OK	60 minutes: User set log period 5 to 1440 minutes, Default 60
Compensation	OK	OK	None. **Note:** Do not apply any type of Compensation to a thermal sensor use to compensate a pH sensor
Measured Level	OK	OK	3126 mV: Raw sensor level in mV, before Gain & Offset after ID Level correction.
Gain Multiplier	OK	OK	259.74: User set Gain. Do not change this value unless you have changed the RTD type.
Default Gain	OK	OK	259.74: Factory default Gain, = 1/ 0.00385 ohm / ohm /c
Offset Adjust	OK	OK	-4.012: Offset. Calibration adjusts Offset. Displayed Value = (Measured Level x Gain Multiplier & RTD to temperature conversion) + Offset Adjust
Default Offset	OK	OK	0.0000: Factory default Offset. Offset selected by Input Card ID
Input Card ID	OK	OK	100 ohm RTD = 43 mV RTD drive measurement level 1000 ohm RTD = 327 mV

Sensor Type	Default Gain	Calibration Offset Span	Default Offset
RTD	259.74	+20 to -20	0

Calibration: A calculated offset outside of the Calibration Offset Span requires a user selected Override to complete calibration.

7.7.4 Specifications

Function		Notes
Input Range	0-14 pH 100 ohm or 1000 ohm Platinum RTD.	Defaults to 0.00385 ohm/ohm/C RTD, Resistive Thermal Device
Resolution	pH: 0.01 pH Temperature: 0.1C or 0.05F	User controls pH and temperature displayed resolution from 0 to 3 digits after the decimal point.
Accuracy	+/- 0.05F/C +/- 0.02pH	Requires installed solution ground for non-immersion pH sensors.
pH Input Impedance	> 500 MOhm	Fully differential. 20M ohm power OFF input resistance

Notes: Accuracy stated after sensor calibration.

Appendices

A: Revision Log

Issued	Modifies/Adds	Notes
07/03/08	Initial release	Aegis_Tech.PDF on .ftp site
06/30/09 Ver. 6/09	Section 7.4.2 CI Driver Card Adds Loop Current to 4-20mA input Diagnostic	Modbus & Non-Modbus versions modified.