Electronic Water Level Gauge

Installation, Operation And Maintenance of

Aquarian 3000Classic

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*Aquarian 3000C*lassic

Instruction Manual

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About this Manual

This instruction manual describes the architecture and operation of the Aquarian 3000 Classic as supplied by ***Fossil Power Systems Inc.***

Although care was exercised to make this Manual specific and complete, it is not intended that it and its accompanying equipment manuals should provide for all potential operating and maintenance conditions. It must be recognized that no amount of written instruction can replace intelligent thinking and reasoning on the part of qualified personnel. It is the responsibility of these personnel to become completely familiar with the mechanical, electrical and control systems involved, including their characteristics and performance under various operating conditions.

This knowledge can be obtained through the basic information provided in this manual, supplemented by advice and recommendations from this Company's field agents and by actual experience.

The nature of the electronics, the harsh operation environment and the potential hazards associated with live steam require that only qualified personnel install and maintain the equipment.

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installation, operation and maintenance of *Aquarian 3000Classic* electronic water level gauge

1 INTRODUCTION

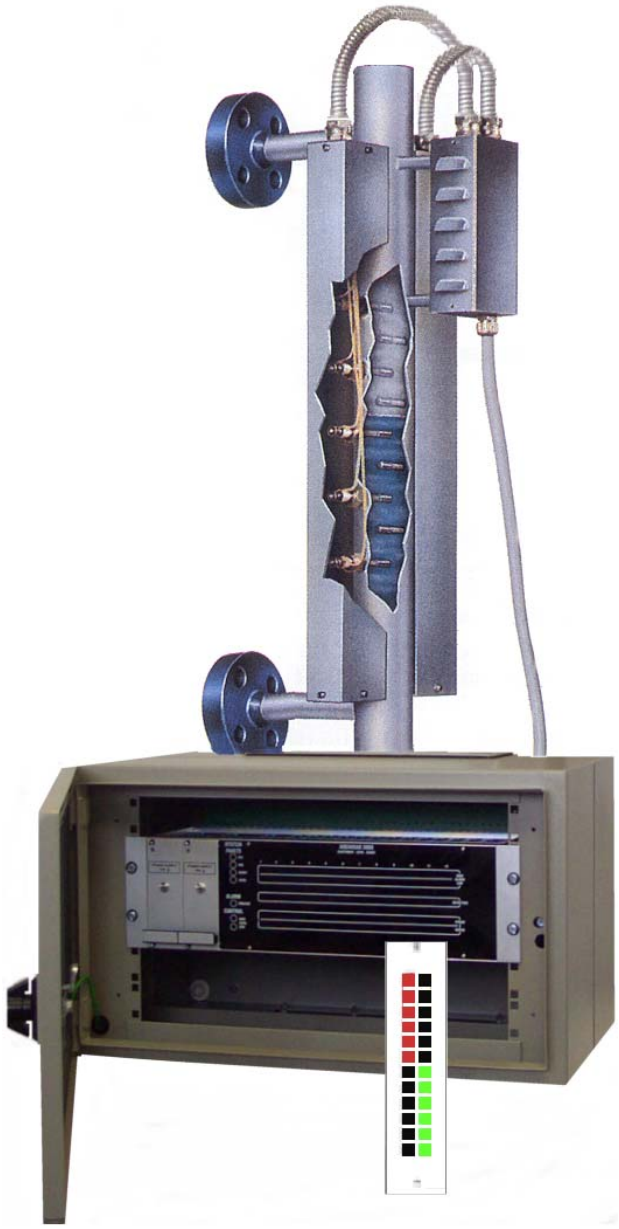
The Aquarian 3000 Classic satisfies basic level indication needs utilizing vacuum brazed probes for boiler drum, feedwater heaters and other liquid level applications.

It is complete with control outputs and internal system fault monitoring, indication and fault output. The Aquarian system consists of a column with high temperature and pre-wired junction box, the detection and verification (D&V) unit, and the remote display.

The electronic system in the D&V unit is connected to 5, 8, 10, 12 or more probes on the water column. The number of probes can be selected and spaced to indicate liquid level through a desired operating range. The Aquarian column is custom manufactured to provide the most accurate indication for any application. Column mounted probes with ceramic insulators have been used and proven reliable for many years of service.

The drawings supplied for each installation specifies the tapping point spacing on the pressure vessel, the number of probes and their positions.

Prior to performing any work, personnel responsible for the installation of the system should read these instructions and become familiar with the unit.



2 PACKAGING

The Aquarian 3000 Classic with the column is packed on one pallet weighing approximately 200 lb (91 Kg). Prior to installing this equipment, clean all packing material from around the unit and inspect for any damage that may have occurred during shipment.

The Detection and Verification Cubicle has double opening front panels. The operator interface panel and the power supplies are packaged behind the second front panel. Remove and inspect the power supplies for any damage, check for correct fusing, then replace covers and fix with the screws provided.

The purchaser must file any claims for loss or damage with the carrier. The manufacturer, on request, will furnish a copy of the bill of lading and freight bill if occasion to file a claim arises.

3 INSTALLATION

3.1 Location of the Electronics

Water with low conductivity requires a higher sensitivity. The highest sensitivity limits the cable distance between probe and electronic module to 65 feet (20m). The lowest sensitivity allows the cable distance to be up to 500 feet (152m). A DIP switch on each D&V module is used to select the conductivity range of the unit. The highest conductivity mode should be used where possible. The coolest, most accessible location for mounting the electronics is preferred.

3.2 Pressure Vessel

The pressure vessel is fixed to the steam drum either by being welded directly to the isolating valves or welded to flanges that mate to existing flanges on the steam drum tapping points. A steam inlet line must be installed to provide a free flow of steam to the column. Valves in the steam line must be installed with stem horizontal.

The steam line must slope down toward the column (a slope of 2% is recommended). Ideally, the return water leg should be horizontal. This leg may, however, be sloped down to the drum, in which case it must be insulated. In no case should the steam line be insulated.

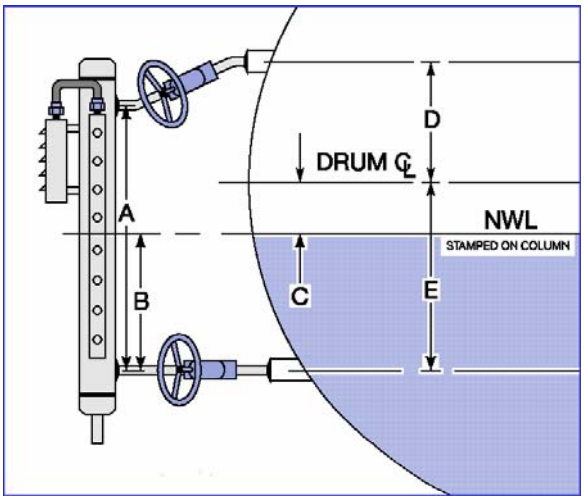


Figure 1 - Vessel Installation

IMPORTANT Consult the factory if conditions require the use of other types of fittings or special mounting configurations. All welding should be done in accordance with approved procedures as required by applicable specifications. Isolation and blowdown valves should be selected and installed as outlined in the latest edition of the ASME Power Boiler Code, Section 1, and be capable of tight shut-off.

Pressure vessels with two pressure ratings are available – a 2000 psi stainless steel design and a 3000 psi stainless steel design.

The fittings on steam generators of lower pressure usually have a lesser rating. As a result, the rating of the package is governed by the lowest rating of any one of the fittings. Outside applications require a weather shield.

The metal probe shields should be removed and remain off until the system is placed in service and a satisfactory inspection of all the probes and the associated wiring is completed. Refer to Section 3.3 to install the probe and Swagelok nut.

All screws must be tightened and reinstalled if removed.

If the housing is damaged and cannot be properly secured, it may cause a short circuit and must be replaced.

3.2.1 Freeze Damage Precautions

Installations and locations that may expose the pressure vessel column to low temperatures must take precautions to prevent water in the column from freezing. Water that freezes in the pipe column could damage the probes. Several options to prevent damage include: protecting the column with a heated enclosure, draining water from the column when the boiler is shutdown, and installing insulation with heat tracing. The column junction box should not be insulated since the wire connected to the electronics could be damaged.

3.3 Probes

The Aquarian product is supplied with zirconium insulators. The high-pressure probes have a 0.490-inch diameter body and are easily recognized by the brazing between the insulator and the body.

IMPORTANT The two probe hex head nuts located on the post used for the electrical connection have been pre-torqued to exact specification prior to shop testing. If the hex head nuts are inadvertently loosened, the probe must be replaced. Probes are supplied fully assembled. Probe receptacles on the pressure vessel are Swagelok fittings.

To ensure the probes remain clean, mount the receptacles such that the probes are exposed to mild fluid circulation. Do not locate the probes in high velocity steam or water. Probes may be located horizontally, or vertically with the electrical connection up.

Figure 2 - Probe Assembly

For Probe removal refer to Section 6.2 for information on removal, inspection and re-installation.

3.4 Detection & Verification Modules

The Detection and Verification Modules are located in the guides to the right of the System Monitor Module. For each probe in the pressure vessel there is a dedicated Detection and Verification circuit, circuit failure diagnostics, alarm High/Low Module. Each

module can be considered a separate channel because of its individual on-board detection and non-cancelable alarm logic, and display panel light-driving circuitry.

3.5 Wiring

CAUTION Before making any connections, make sure that the power source to be used is isolated by use of the appropriate circuit breakers and switches so that no work is being performed with "live wires". Do not run input power through spare conductors in multi-conductor cables used for probe and display panel wiring. Input power is to be run in separate power cables.

It is recommended that all Modules be removed from the Aquarian 3000 Classic rack prior to performing any wiring on the unit.

All wiring should be in accordance with applicable national and local codes by qualified personnel.

3.5.1 At the Probes

Reference:

- Figure 3 - Aquarian 3000 Classic 10-12 Probe System Wiring
- Figure 4 - Aquarian 3000 Classic 5-8 Probe System Wiring

The cabling between the junction box and the Electronic Module inside the D&V unit does not require any high temperature capability. It is recommended, however, the cable should have an overall shield, 18-20 gauge tin plated wire and have a rating of 221°F (105°C).

Each electronic module can handle the input from a maximum of twelve probes. Connect the probe wire to the appropriate level terminal. Ground wires should be connected to the column ground.

The lowermost probe is numbered 1 and the corresponding terminal in the Electronic Module is P1. Wire successively higher probes in the same manner.

IMPORTANT The ring tongue crimp terminal is to be inserted on the probe terminal post between the thumbscrew and the two hex head nuts.

Do not loosen the two hex head nuts.
Do not use excessive force to tighten the thumbscrew.

The probe ground wire is to be connected to the ground screw provided in the probe cover.

These wires should be run to an appropriate junction box. The wire connecting the probes to the electronic module from the junction box should be shielded 18 AWG or 20 AWG stranded, and either tin plated or silver plated copper. UNPLATED COPPER WIRE SHOULD NOT BE USED.

3.5.2 At The Electronic Module

Reference:

- Figure 3 - Aquarian 3000 Classic 10-12 Probe System Wiring
- Figure 4 - Aquarian 3000 Classic 5-8 Probe System Wiring

For reliable operation, a power source with the following requirements is necessary.

120 VAC or optional 240 VAC
Single Phase, 50/60 Hz
1 Amp / ½ Amp

Higher voltage will require the use of a stepdown transformer. DC voltages will require use of a voltage inverter.

The Aquarian 3000 Classic will work with either one or two supplies. These supplies can be of different voltages, as long as the basic requirements are met as shown above.

Metal jumpers are provided for setting the input supply voltage. They are factory placed for supplies of 120 VAC using two jumpers per power supply module. For 240 VAC operation, the jumpers have to be relocated. Only one jumper per power supply module is required in this case. The jumper location for the two input voltages is silk-screened on the motherboard.

Make sure all power supply switches are in the "OFF" position. Input power should be connected to the terminals designated "L1A", "L1B" (line) and "L2A", "L2B" (neutral). The "G" (ground) terminal must be connected to a safety ground.

If only one supply is available, L1A should be jumpered to L1B and L2A should be jumpered to L2B.

The user's alarm and protection interlocks wire to terminals numbered 1 to 8 on the motherboard. Careful consideration should be given to the design of the alarm and trip logic. Power loss, vessel blow down or module removal could inadvertently shut down the steam generator or leave the unit without protection.

3.5.3 At the Remote Display Panel

Reference:

- Figure 10 - Remote Display Options

The display panel insert is connected to the Detection and Verification Cubicle by an 18 or 20 AWG multi conductor cable. Shielding is required if electrical conductors other than those for the Aquarian's low voltage display share the same wiring conduit.

Do not use extra Aquarian cable leads for anything other than probes or display panel wiring. Use of these cables for other than what they were intended may cause damage to the electronics.

When several display panels are connected to a single electronic module, each panel can be connected to either the Electronic Module terminal strip or the terminal strip of a preceding display panel. Care must be taken to match the corresponding terminal connections.

Light Emitting Diodes (LEDs) are used on the display panel. These LEDs have an expected 30-year life and can be replaced only on a modular basis.

A lamp test feature is included which will illuminate all lamps when the RESET push button is depressed.

3.6 Control Outputs

Reference:

- Figure 3 - Aquarian 3000 Classic 10-12 Probe System Wiring
- Figure 4 - Aquarian 3000 Classic 5-8 Probe System Wiring

3.6.1 System Alarm (Electronics Fault)

A Form-B type relay contact is provided to allow external monitoring of the operation of the Aquarian 3000 Classic. This relay is normally energized. Loss of power to the unit or detection of an internal fault condition will cause the relay to de-energize, closing the

contact. The fault detection circuit covers clock failure, level fault and two internal power supplies.

3.6.2 Process Alarm

The Process Alarm relay, Form-A type, is available to indicate a low and/or high level alarm condition exists. The relay is energized on an alarm condition.

3.6.3 Low - High Level Trip Outputs

Two Form-A type relays are available for Low-level trip and High level trip outputs. These relays can be set to either energize or de-energize when trip conditions occur. Refer to Sections 4.8 and 4.8.2 for more information.

4 START-UP AND OPERATION

Once all connections and wiring are completed, the unit can be placed into service.

4.1 Indicating Lights

Reference:

- Figure 6 - Face Plate Label

4.1.1 System Monitor Module

The following status indications are displayed on the faceplate:

- PS1 Fault – failure of the first supply.
- PS2 Fault – failure of the second supply.
- Clock Fault – detection circuit clock stopped.
- Level fault – water/steam inconsistency.
- Process Alarm – Alarm is active and relay is energized.
- Low trip – indicates steam level is below a preset level.
- High trip – indicates water level is above a preset level.

4.1.2 D&V Modules

Each Detection & Verification Module displays the following status indications on the faceplate:

- Low Alarm – current level is set for low steam detection.
- High Alarm – current level is set for high water detection.
- Steam – indicates level has detected steam.
- Water – indicates level has detected water.
- Detection – will light during the transition from steam to water.

4.2 Pressure Vessel

To place the vessel in service, the following procedure is recommended.

Inspect the probes to ensure that the installation and associated wiring are correct. Wiring should be neatly routed and any contact between the high temperature vessel body or the probe cover should be avoided.

Warm up and fill the column as follows:

1. Open the blowdown or vent valve.
2. Crack the steam isolation valve and warm up the vessel for a period of 3 to 5 minutes.
3. At the end of the warm up period, close the blowdown or vent valve and then fully open the steam valve.
4. The water connection isolation valve can now be opened, or alternately, if this valve is left

closed, the vessel will fill with condensate allowing the operating range of the device to be verified.

5. The water isolation valve can then be fully opened.
6. Visually check all the probes for any sign of leaks. Replacement of the probe covers using the 1/4" socket head cap screws will complete the commissioning of the vessel.

Notes:

1. Isolation and blowdown valves should be carefully selected and installed as outlined in the ASME Power Boiler Code, Section 1.
2. During vessel blowdown, isolation, or testing, some form of interlocking bypass of the high and low water control outputs may be required to avoid boiler tripping.

CAUTION Before repairing leaks, ensure the water column is properly isolated from the system, all pressure has been relieved and the unit cooled to an acceptable level.

4.3 Power-Up Routine

Once wiring is complete, the cubicle may be loaded with the electronic modules. The Power Supply Modules are located to the extreme left and are loaded first, in any order. The System Monitor Module is located to the right of the second Power Supply Module.

Important These three modules must be placed in the correct positions. Otherwise, severe electronic damage will occur when power is turned on.

After the three modules are positioned, the following precheck is recommended:

1. Switch on Power Supply 1 (PS1); visually check for (a) PS2-Fault indication, and (b) Low level indication (see Section 4.8.2).
2. Switch on Power Supply 2 (PS2). The only indication at this time will be the low-level control output. Leave PS2 on and switch PS1 off. Note that PS1 "Fault indication" occurs.
3. Switch off PS2.
4. Insert all the D&V Modules. The alarm selection switches on the Modules should be positioned to designate the high and low alarm levels.
5. High alarm is selected by closing DIP switch #2. Any modules above the designated high alarm level should be selected for high alarm.
6. Low alarm is selected by closing DIP switch #3. Any modules below the designated low alarm level should also be selected for low alarm.
7. This will provide additional alarm functions if water continues to rise or fall beyond the first alarm limit. If these alarms are to be non-cancelable DIP switch #4 must be set. For low sensitivity application (less than 25 micro mho) DIP switch #1 should be open.
8. Energize the system by switching on both power supplies. The D & V Modules will display the steam indication. Those selected for high and low alarm will show their respective indications as well.

9. Using a series of jumpers and starting from the bottom and working upward, the probes can be shorted to ground to simulate a water condition.

4.4 Sensitivity Control

Reference:

- Figure 9 - System Monitor and D&V Jumper Settings

Inspect the module to ensure that all electrical connections are made and properly protected. Set the sensitivity required for the water conductivity range to be detected.

To change the sensitivity, the faceplate must be removed. On each D&V Module is a four-position DIP switch. The first switch is used to select the sensitivity. For low sensitivity applications, less than 25 micro mho, DIP switch #1 should be left open. For higher conductivity boilers, with cabinet distances up to 500 feet (150 m) away from the pressure vessel, the switch must be in the "closed" position, on each of the Detector and Verification Modules. This mode should be used where possible

*All channels should be set to the same conductivity range. The factory default setting is the **high** conductivity range.*

After setting the sensitivity, power may be supplied to the unit by use of the external circuit breaker or main switch. Turn the power-up switch on the module to the "ON" position. The unit is now operational.

4.5 System Monitor

Reference:

- Figure 9 - System Monitor and D&V Jumper Settings

The Aquarian 3000 Classic is equipped with a fault-annunciating relay that monitors critical internal electronic circuitry. This is the System Alarm Relay and is located on the System Monitor board immediately to the right of the second power supply.

The fault relay is energized and the output contact is closed when no faults are present. Contacts from the system alarm relay terminate on the motherboard at terminals 1 and 2. If the supply power to the device is lost or if one of the conditions listed below were to occur the fault relay would de-energize and the fault contact would open.

The indicator on the display panel reset button is normally on. It will flash at a 2 Hz rate or go out (extinguish completely) when a fault condition is present. The fault relay cannot be reset to a no fault condition by depressing the test/reset button. If the fault condition that caused the alarm has not been corrected, the indication will continue to flash regardless of the reset action. The fault alarm relay will reset only when all faults are corrected. Any new faults, however, would be visually annunciated either on the display panel for a detection error, or on the front edge of the System Monitor Module. The indicator on the display panel button will go out when the System Monitor Module is removed; the light is burned out or the power is off.

Any fault generated falls within one of three categories, each of which is clearly displayed by a flashing (2 Hz) LED on the front edge of the monitor board. The categories are as follows:

1. PS1-Fault signal generated on failure or removal of the first power supply

2. PS2-Fault signal generated on failure or removal of the second power supply
3. Clock - Failure of the square wave detection clock signal generator

4.5.1 Power Supply Fault

Two separate power supplies (PS1 & PS2) provide logic power for the Aquarian 3000 Classic. The output of both power supplies is diode shared such that if one supply fails, the remaining supply will carry 100% of the system load.

Within each power supply module are two low voltage transformers, rectifiers and filter circuits. Each circuit generates a 16 VDC unregulated output and these outputs are shared through two diodes and then split to serve three functions.

1. One source is directed to the back edge connector on pins 15/S. This unregulated power source is used to drive the Detection and Verification Module, on-board steam/water indicators and also the monitor module alarm and control relays.
2. The second source is fused (2 amp) and routed by the back edge terminals 13/P to A and B on the motherboard. This is the source used to power the remote indicators. If this fuse fails the local indication described above is still functional.
3. The third source inputs an on-board 12 VDC power regulator. The output of this regulator is routed by the back edge terminals 1/A to the System Monitor and the Detection and Verification Modules. This is the logic power source Vcc for the system. To provide 100% back-up each of the outputs noted above are diode-shared between the power supplies 1 and 2.

Each power supply has an internal monitoring system that will generate and send a fault signal to the System Monitor Module if any of the following problems were to occur:

- Power supply module not inserted
- Power supply feed not available
- Power supply not switched on
- Fuse F1 faulty
- Fuse F2 faulty
- Failure of transformer or rectifier PS1
- Failure of transformer or rectifier PS2
- Failure of 12 VDC regulator.

Each supply has a full bridge rectifier, filter and 12-volt voltage rectifier. The two DC supplies share a low voltage transformer with fused input. If a fault were to occur within any part of this circuit the fault circuit would de-energize the fault relay and turn on the PS1 or PS2 LED to indicate the fault area.

The input to the power supply modules is routed via the motherboard to the module's back edge connector. Fuses are located in each power module.

Replacement fuses should be rated as follows. Fuse F1 provides overall protection of the power supply module:

Fuse F1 – 1 Amp 250VAC
3AG Normal Blow
Littlefuse number 312001

Fuse F2 provides protection of the 16 VDC unregulated bus to power the remote display panel:

Fuse F2 – 2 Amp 250VAC
3AG Normal Blow
Littlefuse number 312002

4.5.2 Clock Fault

A 1 Hz square wave is used as the timing base for the DC detection circuit.

A failure of the clock circuit will not affect the ability of the device to sense water, although over the long term (3000 hours or more) electroplating will take place. In the short term, therefore, the failure is not serious. If a fault does occur, the clock fault LED will turn on.

4.6 Process Alarm (Level Alarm)

Process Alarm – Level verification error on one of the D&V Modules. The suspect module or faulty level can be identified by the 2-Hz flash rate (either steam or water) on the display panel of the respective module.

The process alarm signal can be generated in any of the Detection and Verification Modules. To condition the modules for alarm functions the DIP switch on each D&V Module must be set for the desired alarm (Hi/Low) condition.

When an abnormal level is detected and verified by the detection module, the resultant alarm signal generated is bussed from the Detection and Verification Modules via the motherboard to the System Monitor Module. The signal drives the process alarm indication on the front of the monitor board and energizes the Process Alarm relay. Contacts from this relay (normally open) terminate on the motherboard at terminals 3-4.

Simultaneously with the operation of the process alarm relay, there is a remote flashing indication on the remote operator display panel. The output flashes at a slow 1-Hz rate which distinguishes the process level fault from the equipment or system fault which flashes at a 2-Hz rate.

Note:

1. The process alarm relay, the Monitor Module process alarm indication, and the flashing operator interface panel indication all reset when the reset pushbutton is depressed. If the water level continues to rise (fall), the alarm setting for the next level will re-initiate all the alarm functions.
2. If the non-cancelable alarm feature along with the alarm feature have been selected on the Detection and Verification Module, the control action changes. In this instance, the action of depressing the reset button is only held in memory and the alarm annunciation clears only when the abnormal condition is corrected.

4.7 Level Alarm Selection

To annunciate abnormal level conditions the on-board alarm circuitry can be activated by DIP switches No. 2 or 3. When DIP switch No. 2 is closed the high level alarm logic is enabled and the on-board High Alarm LED illuminates to indicate the circuit is active.

When water is sensed at a module selected for high alarm the condition is latched in memory causing the following actions:

- The water indication on both the Detection and Verification Module and the remote display flash at a 1-Hz rate, and
- The alarm relay is energized on the System Monitor Module

Depressing the reset button on the remote display will clear the flash and de-energize the alarm relay. However, the alarm circuitry on that specific Detection and Verification Module will not re-enable itself until the level falls at least two probes below it. This feature provides hysteresis and avoids an alarm-reset-alarm action if the water is flirting about the alarm level.

When DIP switch No. 3 is closed the low level alarm logic is enabled and the on-board Low Alarm LED illuminates to indicate the circuit is active.

When the absence of water is sensed at a module selected for low alarm the condition is latched in memory causing the following actions:

- The steam indication on both the Detection and Verification Module and the remote display flash at a 1-Hz rate, and
- The alarm relay is energized on the System Monitor Module

Depressing the reset button on the remote display will clear the flash and de-energize the alarm relay. However, the alarm circuitry on that specific Detection and Verification Module will not re-enable itself until the level moves at least two probes above it. This feature provides hysteresis and avoids an alarm-reset-alarm action if the water is flirting about the alarm level.

4.7.1 Non-Cancelable Alarm Selection

Closing DIP switch No. 4 will alter the alarm reset action. In this instance, depressing the reset push button sets an internal memory in the Detection and Verification Module logic. The flashing indication continues, the alarm relay remains energized, and will reset only when the water level abnormally is corrected.

The alarm reset push button also turns on both the Steam and Water indications as a lamp test.

4.8 Level Trip Control Outputs

Reference:

- Figure 7 - Backplane Jumper Settings for 10-12 Probe Systems
- Figure 8 - Backplane Jumper Settings for 5-8 Probe Systems

The high-level and low-level control provides two relay outputs that are suited for a number of control applications. Some flexibility has been provided for choosing the level at which the device activates.

4.8.1 High-Level Control Output

The four uppermost probes can be selected to the circuit by programming a DIP switch on the motherboard. To select the probes to be active in the counting circuit, close the appropriate switch contacts.

The output of the High Level trip relay normally open contact terminates on the motherboard at terminals 5-6. The relay is energized in normal level operation.

Please note that loss of power or removal of the system monitor module from the rack will indicate a "high level" condition.

Also, to allow for some redundancy or back up, it is also possible to program a counting

circuit which determines how many probes must sense water to activate this output. This function is set by means of a second DIP switch located on the System Monitor Module. A one-vote or two-vote option is available.

For example, if the three highest probes were selected to the counting circuit and a two-vote scheme was employed; a control output would be generated once any two out of the three probes sensed steam.

Important If a 2-vote scheme is used (switch closed) ensure at least 2 probes are selected to the counting circuit.

To select the voting scheme, the DIP switch position No. 1 is set on the front of the monitor board. When this switch is closed, 2 votes or 2 levels detecting water are required to activate the output relay. When switch No. 1 is open only one vote is required.

Important If any of the Detection and Verification Modules were removed, the signal to the high-level control output counting circuit would be seen as a steam indication. Therefore, if the modules selected to the trip circuit were removed, the high level circuit would be rendered inactive.

4.8.2 Low level Control Output

The bottom four probes can be selected to the circuit by programming a DIP switch on the mother board. To select the probes to be active in the counting circuit close the appropriate switch contacts.

The output of the Low Level trip relay normally open contact terminates on the motherboard at terminals 7-8. The relay is energized in normal level operation.

Please note that loss of power or removal of the system monitor module from the rack will indicate a "Low Level" condition.

When a low level is detected, the "Low Level" indicator flashes at a 2-Hz rate and the relay de- energizes.

Also, to allow for some redundancy or back up, it is also possible to program a counting circuit that determines how many probes must sense the absence of water (steam) to activate this output. This is set by means of a DIP switch on the System Monitor. A one-vote or two-vote option is available.

For example, if the two lowest probes were selected to the counting circuit and a one-vote scheme was employed; a control output would be generated when either of the two probes sensed water.

Important If a 2-vote scheme is used (switch closed) ensure at least 2 probes are selected to the counting circuit.

To select the voting scheme the DIP switch position No. 4 is set on the front of the monitor board. When this switch is closed, 2 votes or 2 levels detecting steam are required to activate the output relay. When switch No. 4 is open only one vote is required.

Important If any of the Detection and Verification Modules are removed, the signal to the low level control circuit would be seen as a "no water" or steam indication. Therefore, if the modules selected to the counting circuit were removed, the low level control relay would be activated.

4.9 SENSING FAULT

4.9.1 Improper Water Detection

Any time water is sensed and adjacent levels above and below are not detecting water the system alarm is activated. This flashes the on-board "WATER" indicator at a 2-Hz rate and, as well, flashes the respective green indicator on the operator interface panel. The flashing indication indicates a level is detecting water out of step to the other detection circuits. Three possible causes of fault in this case should be investigated:

1. Shorted probe - Remove the wire on the probe post. If the fault clears the probe is suspect, it should be removed and tested.
2. Shorted lead wiring - The wiring to the probe may have shorted to the hot surface of the pressure vessel or the vessel probe cover. The wiring may also be intertwined with other non-related wiring carrying high voltage. The wiring within the cabinet should be checked.
3. Fault Module - Replace the D&V Module.

4.9.2 Improper Steam Detection

If water is not sensed and water is detected at two adjacent levels immediately above the system alarm is activated. The on-board "STEAM" indicator will flash at a 2-Hz rate causing a respective indication on the operator interface panel to flash red at 2-Hz rate. The 2-Hz rate flash rate suggests that there is a detection failure.

Three possible causes of this fault should be investigated:

1. Module faulty - Replace module.
2. Probe wiring faulty - Inspect the wire terminations and continuity between the probe and the D&V cubicle. Grounding the connection at the probe end should give a water indication; if it does not, check the continuity of the wiring.
3. Improper calibration – Any installation that has, or on occasion has, water conductivity of less than 25 micro mhos requires DIP switch position 1 to be selected to the high sensitivity mode (switch open).

5 DETECTION THEORY

A symmetrical square wave with a period of 1 second is generated in the Aquarian 3000 Classic System. This signal is input to each of the detection circuits and, through a resistor, to the probe field terminal blocks.

When the probe tip is immersed in water a current path to ground is completed and the current flow through the circuit causes a voltage differential to appear across a reference resistor in the electronic module. The voltage is measured at the +VE input of an amplifier and compared to a fixed value at the -VE input of the same amplifier. When the differential exceeds the fixed setting the amplifier outputs a signal indicating the presence of water.

One of three of these fixed settings, or "sensitivities" is selected as explained in Section 4.4 (a lower conductivity water is said to require a higher "sensitivity"). Select the lowest sensitivity that will work with your application. The intermediate or low sensitivity settings increase the maximum

cable distance between probe and electronic module to 165 feet (50m) and 500 feet (152m) respectively. Otherwise, the cable distance must be limited to 65 feet (20m).

6 MAINTENANCE

Each boiler installation is subject to varying operating and water conditions. Generally, the higher operating pressure units (>1800 psi or 125 bar) have improved water treatment and maintenance is minimal.

6.1 Pressure Vessel

A specific maintenance program is difficult to detail but the following outlines the minimum required:

1. The vessel should be blown down and visually inspected for leaks every 3 months.
2. The operating range of the device should be verified at this time by allowing the vessel to fill with condensate (see Section III for Placing Vessel in Service).

6.2 Probes

The voltage to the probes from the electronic cubicle is a square wave of approximately ±5VDC with respect to ground; therefore no electrical hazard is present while working on a powered system.

Caution

Before servicing the probes, ensure that the water column is properly isolated from the system, all pressure has been relieved and the unit cooled to an acceptable level.

6.2.1 Probe Removal

1. Establish that the pressure vessel is properly isolated from the steam drum and all pressure has been relieved.
2. Loosen the nut approximately 1 turn and then free the probe to verify all pressure has been relieved. The metal-to-metal sealing surface initially may cause the probe to stick, so carefully free the joint by tapping the probe on the metal body. **Do not strike the alumina insulator and do not use a wrench to turn the probe hex nuts.**
3. After the probe becomes free, loosen the nut fully and remove the probe.

6.2.2 Probe Inspection

The probes should be removed and inspected after the first 12 months. Thereafter, they should be inspected as required, depending upon the degree of problem contamination.

1. Severe deposits on the probes indicate that inspection should be more frequent. A common household powdered cleaner (i.e. COMET) may be used to clean the probe body and the insulator. After cleaning, the probes should be wiped off with a dry, clean cloth (do not immerse the probe in liquids). Probes that show any signs of damage, insulator cracking, or steam leaks must be

replaced immediately. Do not attempt disassembly of the probe components.

2. Use an Ohmmeter to check the integrity of the probe. Resistance measurement across the insulator of 5 Meg ohms or greater indicates the probe is in good condition and will continue to perform satisfactory. If the unit is operating in the low sensitivity mode, a resistance value of 500K is acceptable.
3. After the probes have been inspected, cleaned and tested, they can be installed following the steps outlined in the probe installation procedure.
4. Do not leave an open receptacle on the pressure vessel. If for any reason a probe is not immediately re-installed, the port should be plugged with a Swagelok plug No. SS810P (1170-0302), and tightened following the probe installation procedure.
5. The unit can now be placed in service by following the steps outlined in the start-up procedure (Section III).

6.2.3 Probe Installation

1. Establish that the threads and sealing surfaces are clean.
2. Insert the probe into the receptacle and snug up the Swagelok nut by hand.
3. Tighten with a wrench 1/4 turn only.
4. The threads on the probe receptacle and Swagelok nut should be re-lubricated each time the probe is reinserted.

The recommended anti-seize compounds noted below prevent galling and will lower take-up torque on the threaded parts:

Silver Goop (Swagelok trade name)
MP-50 Moly Paste (Jet Lube of Canada)
Never Seez (trade name)

CAUTION Any malfunction of the equipment should be attended to immediately. Although any single channel will fail safe, the overall package is designed for continued operation. Compounding faults, however, could defeat the internal self-diagnostic logic, providing misinformation to the operator and possibly subjecting the boiler to potential hazard or nuisance trips.

7 SPARE PARTS

The following spare parts are recommended as a minimum set for stocking by the user.

Part No	Systems In Plant		
	1	2	3 or more
9300-0002 Probe	2	4	6
9310-9352 Power Supply Module	1	1	1
9310-9350 Detection & Verification Module	1	1	1
9310-9513 System Monitor Module	1	1	1
9310-9501 Auxiliary Relay Module	1	1	2

7.1 Individual Part List

Description	FST Part Number	Former Yarway Part Number
Electronic Module (no Cubicle) For Nema 12 or Nema 4 enclosure State supply 120VAC or 240VAC	9310-9510	96458-18
Power Supply Module	9310-9352	964584-02
Detection & Verification Module	9310-9350	964584-03
System Monitor Module	9310-9513	964584-04
Auxiliary Relay Module	9310-9501	
Remote Display	Please supply system serial number	
4-20 mA Module	9310-9361	966111-**
Low Pressure Probe	9300-0010	964584-52
High Pressure Probe	9300-0002	964584-01
Junction Box Junction Box with Continuity	9300-2005 9300-2000	964584-05, 964584-22 972349-56
High Temperature Wire: One Conductor	6600-0004	965607-**

8 SPECIFICATIONS

Supply Voltage	120 (105-125) VAC 240 (210-250) VAC
Supply Frequency	50-60 Hz
Supply Current	1 Amp @ 120VAC ½ Amp @ 240VAC
Output Voltage	
Probes:	± 5 VDC
Relay Contact Rating	5 Amp at 30 VDC (resistive) 5 Amp at 120 VAC (resistive) 3 Amp at 120 VAC (inductive) 5 Amp at 240 VAC (resistive)
Operating Temperature	
Electronics:	32°F - 140°F (0°C - 60°C)
Column:	750°F (400°C)
Enclosure	
Type:	NEMA 12 (NEMA 4 & NEMA 4X optional)
Dimensions:	13¾“ x 23½” x 15¼”
Weight:	220 lbs (100 Kg)
Wiring Requirement	
Maximum Distance:	500 ft @ ≥ 25 micro mho 65 ft @ < 0.5 micro mho
D&V Cubicle to Column Junction Box:	18 - 20 AWG shielded 221°F (105°C), PVC 12 or 18 conductor, working voltage 300VAC
D&V Cubicle to Remote Display:	18 - 20 AWG non-shielded 221°F (105°C), PVC 25 or 30 conductor, working voltage 300VAC
Standards:	CSA Approved LR55061 CE, FM, SAQ, ASME Section 1, B31.1 Fossil Steam is an ISO 9002 Registered Company

Specifications and descriptions are subject to change without notice.

9 AVAILABLE OPTIONS

Additional options can be purchased to customize the Aquarian 3000C System to individual applications:

- Additional remote displays
- Chrome-moly column 1660 psig @960°F
- Stainless steel column 2000 psig @750°F
- Stainless steel column 3000 psig @750°F
- 4-20mA analog output
- Auxiliary relay module
- Trip bypass pushbutton

9.1 Auxiliary Relay Module

To Order Specify Item Code:

- 9310-9501

An auxiliary Relay Module is available as an option to supplement the control outputs already present in the System Monitor Module. This module provides four additional relays that are programmed by soldering jumper links to the module.

The Auxiliary Relay module is factory programmed to user specifications to permit fast mounting into the "X" guide located to the right of the Detection and Verification Modules.

Programming establishes the following module parameters:

1. Actuation level - Each relay can be actuated by any probe. As many as two relays can be actuated by a single probe.
2. Actuation medium - Each relay can be actuated by either steam or water.
3. Contact mode - Each relay can be selected for either normally open (NO) or normally closed (NC) contact outputs.
4. Four LED readouts are provided to indicate when each relay is energized.

Contact outputs are located on the monitor board on terminal blocks X1 to X8, and are connected according to the following table:

The relay contacts have the following electrical ratings:

5 Amp at 30 VDC or 120 VAC
3 Amp Inductive
1/8 HP at 120 v a-c

9.2 Analog 4-20 mA

To Order Specify Item Code:

- 9310-9623

The Aquarian 3000 Classic Analog 4-20 mA Module is an intelligent I/O card that fits in the "X" slot. It is designed primarily to provide an isolated 4-20 mA output signal. It is configured as a standard two-wire process control current loop.

The output is an analog representation of the height of water in the column. The water height is determined by the existing logic in the Aquarian 3000 Classic system.

Features include:

- An isolated two-wire 4-20 mA industry standard current loop interface.
- Module Alarm contact output.
- Additional relay output based on probe level.
- Indicators showing status of the relay, processor and 4-20 mA signal.

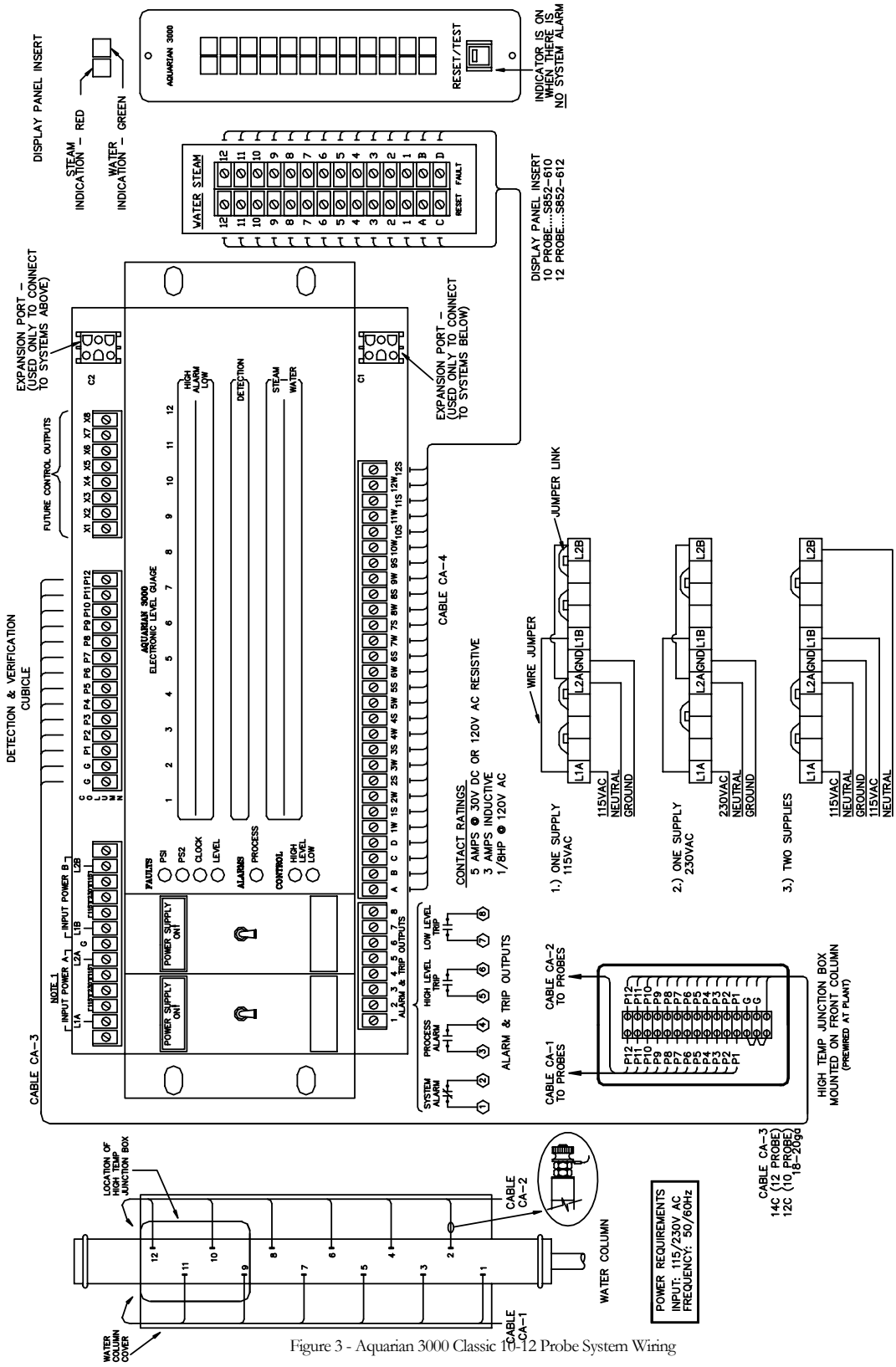


Figure 3 - Aquarian 3000 Classic 10-12 Probe System Wiring

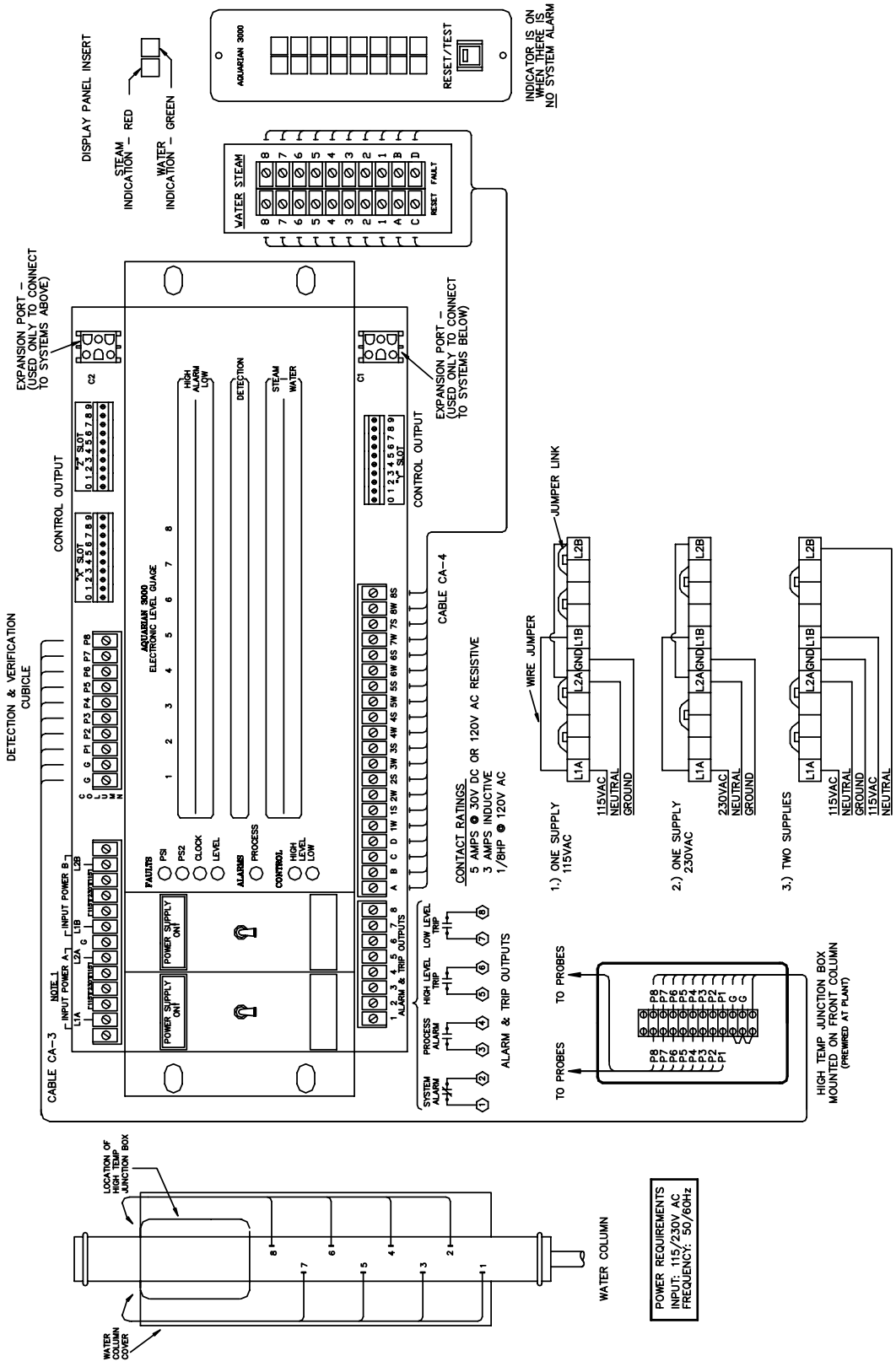


Figure 4 - Aquarian 3000 Classic 5-8 Probe System Wiring

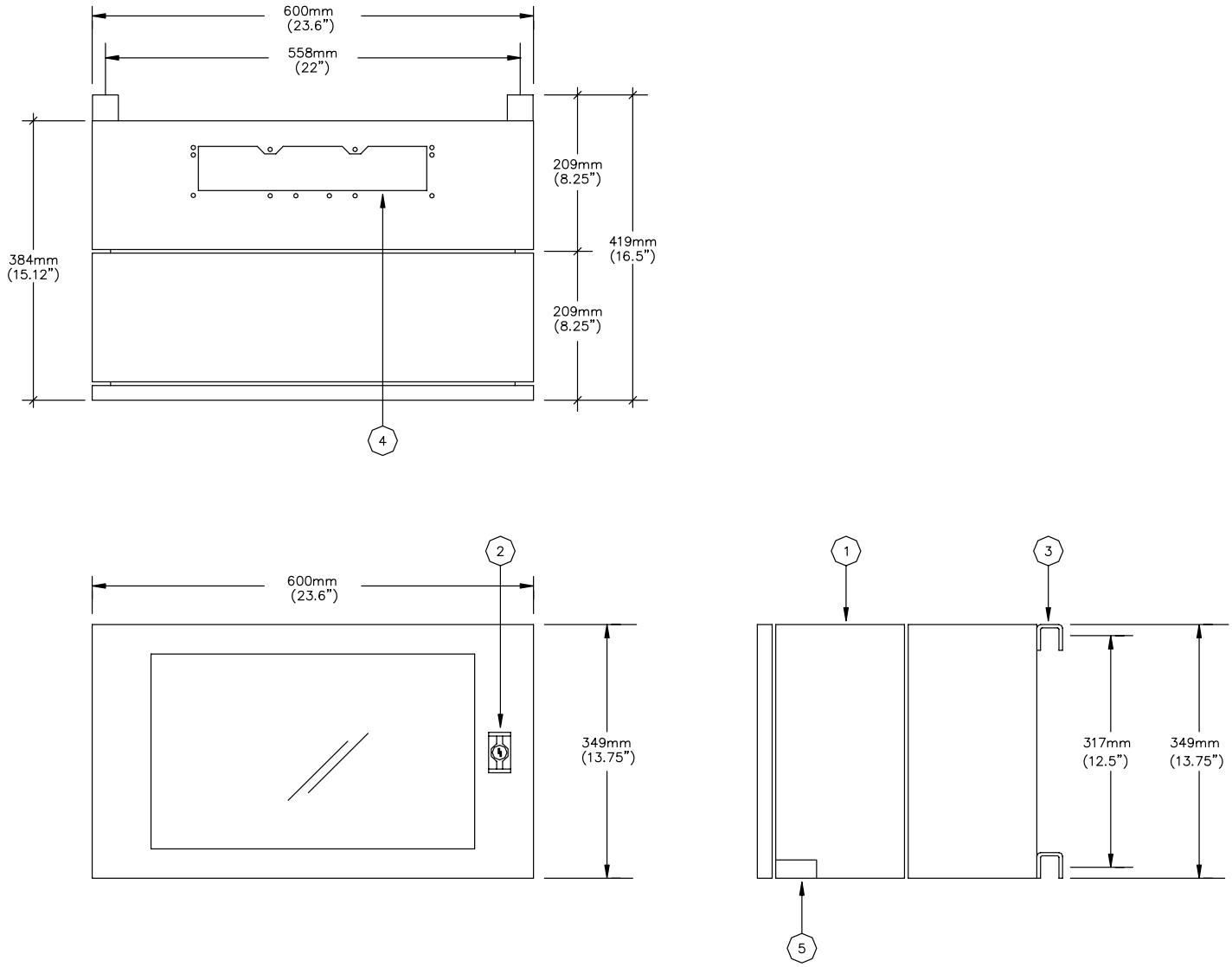


Figure 5 - Nema 12 and Nema 4 Cabinet Dimensions

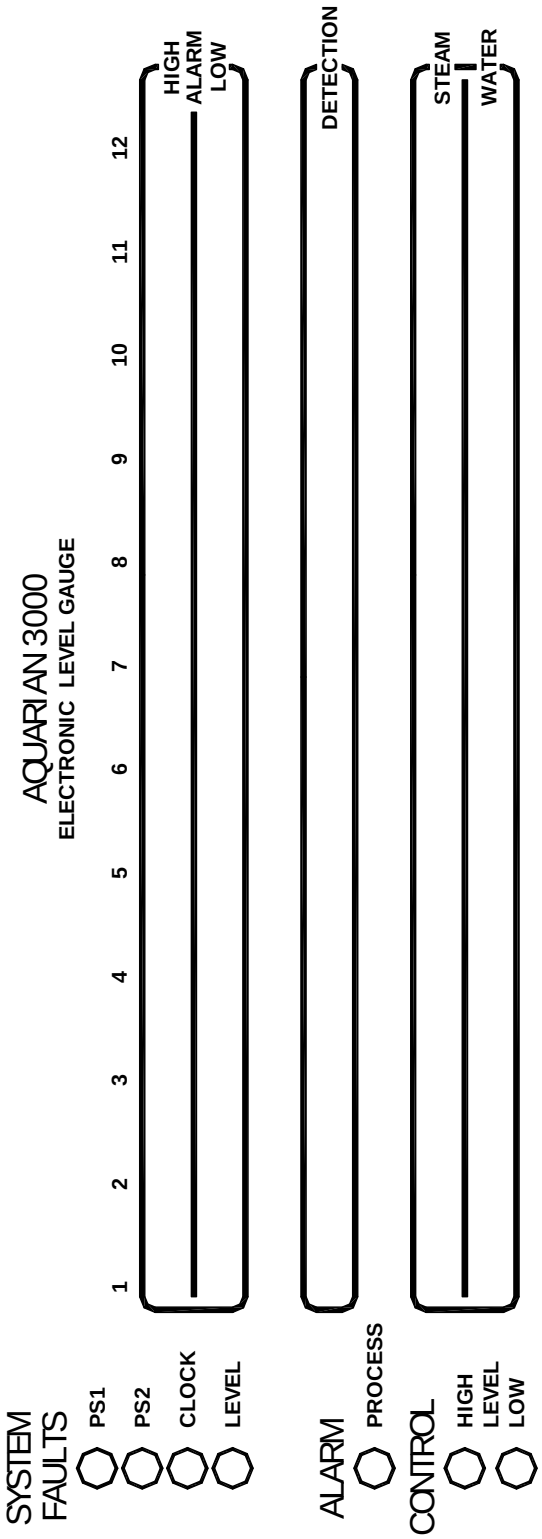


Figure 6 - Face Plate Label

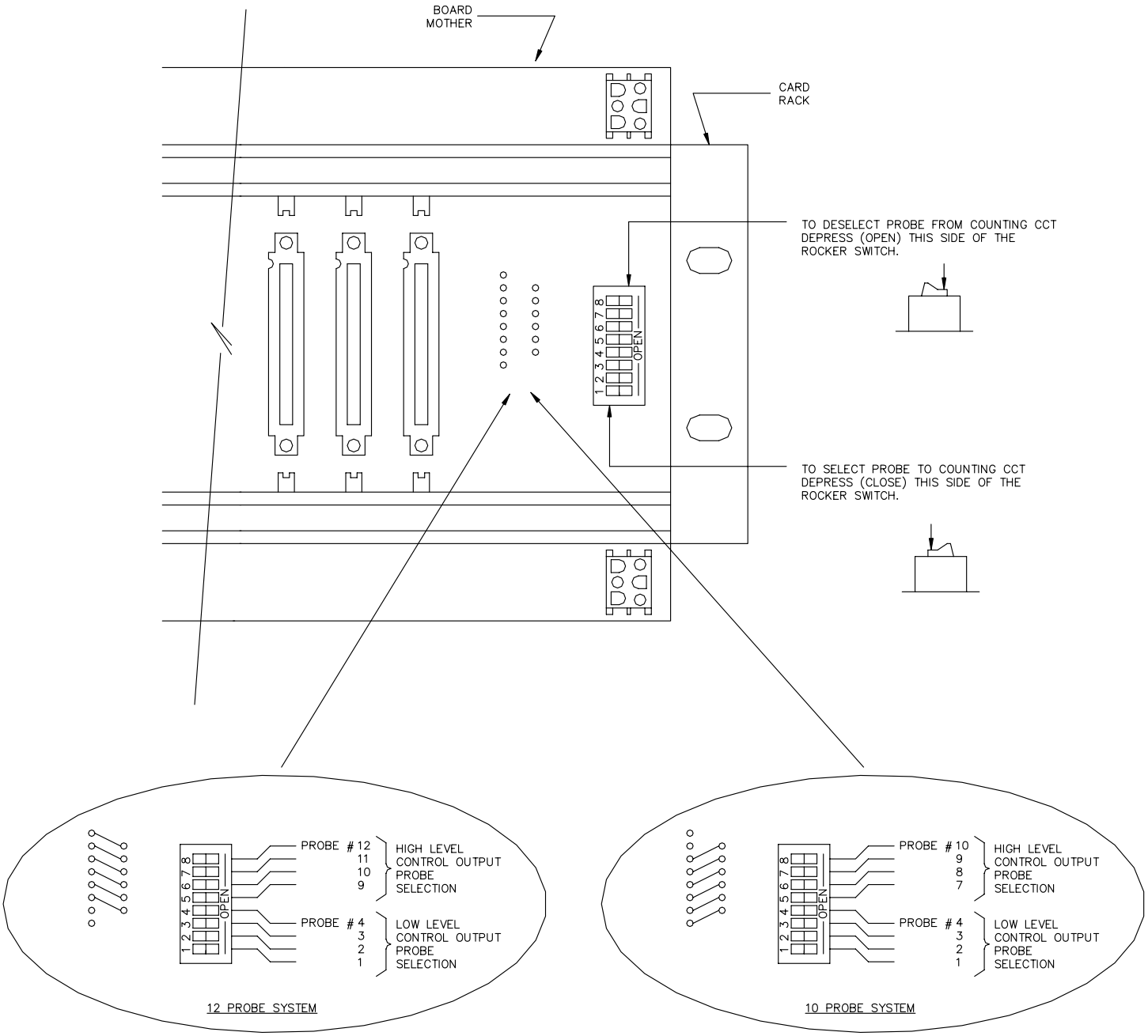


Figure 7 - Backplane Jumper Settings for 10-12 Probe Systems

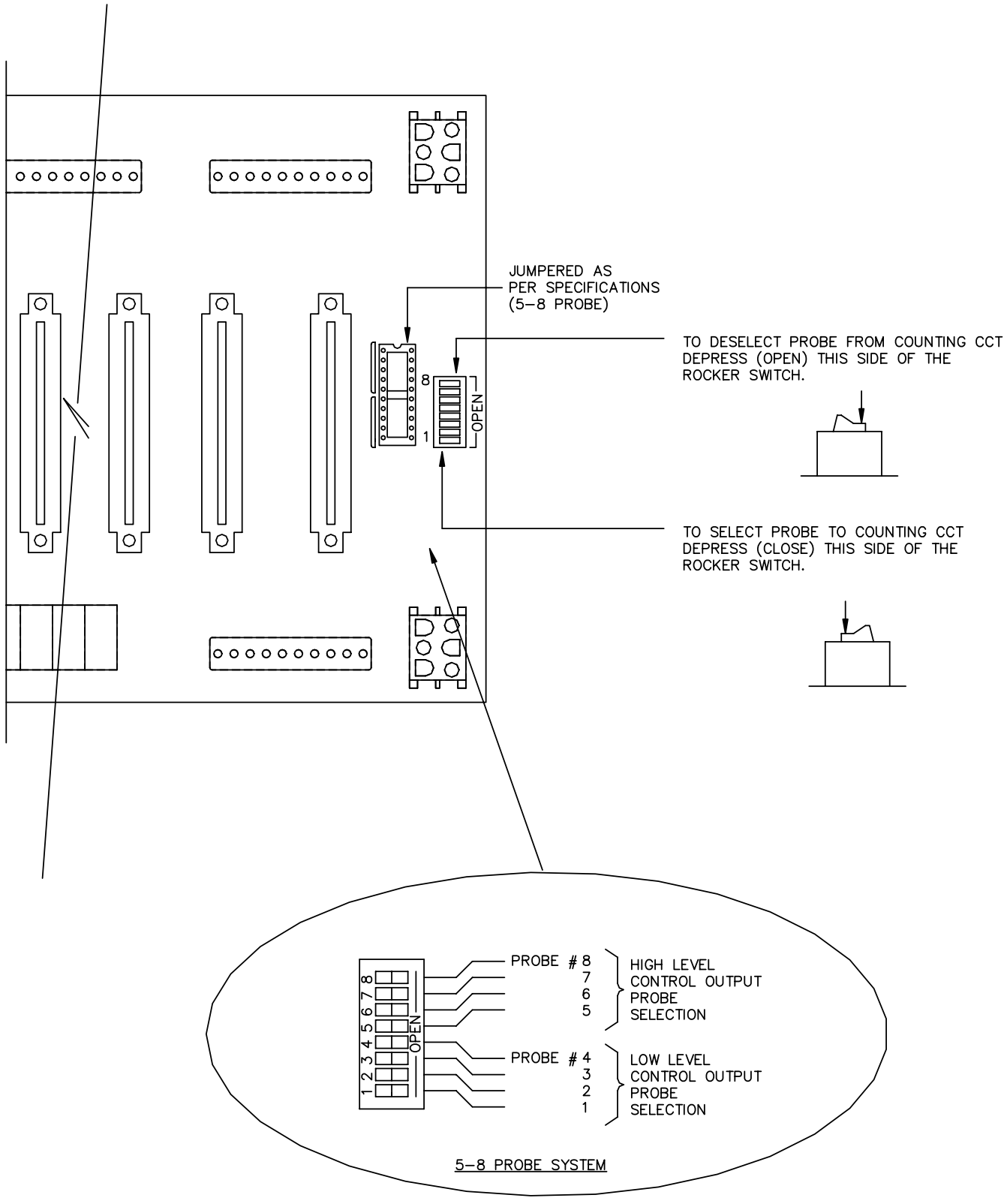
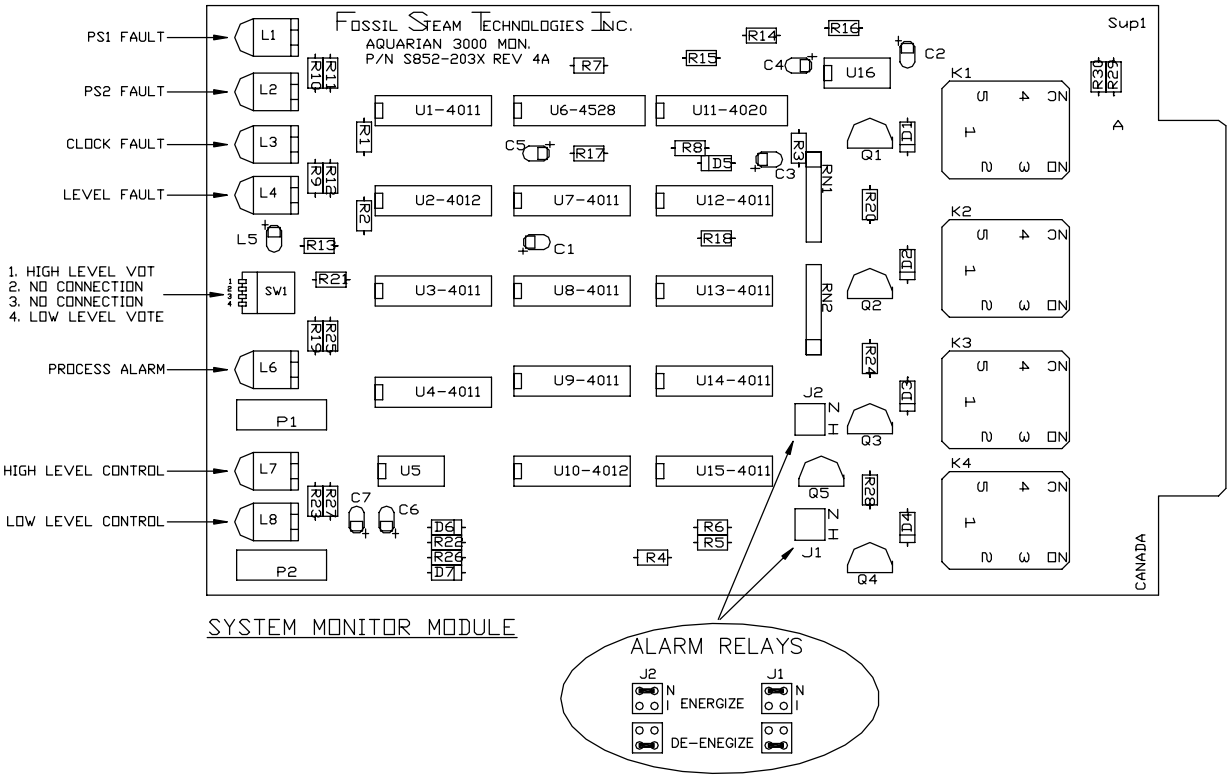


Figure 8 - Backplane Jumper Settings for 5-8 Probe Systems



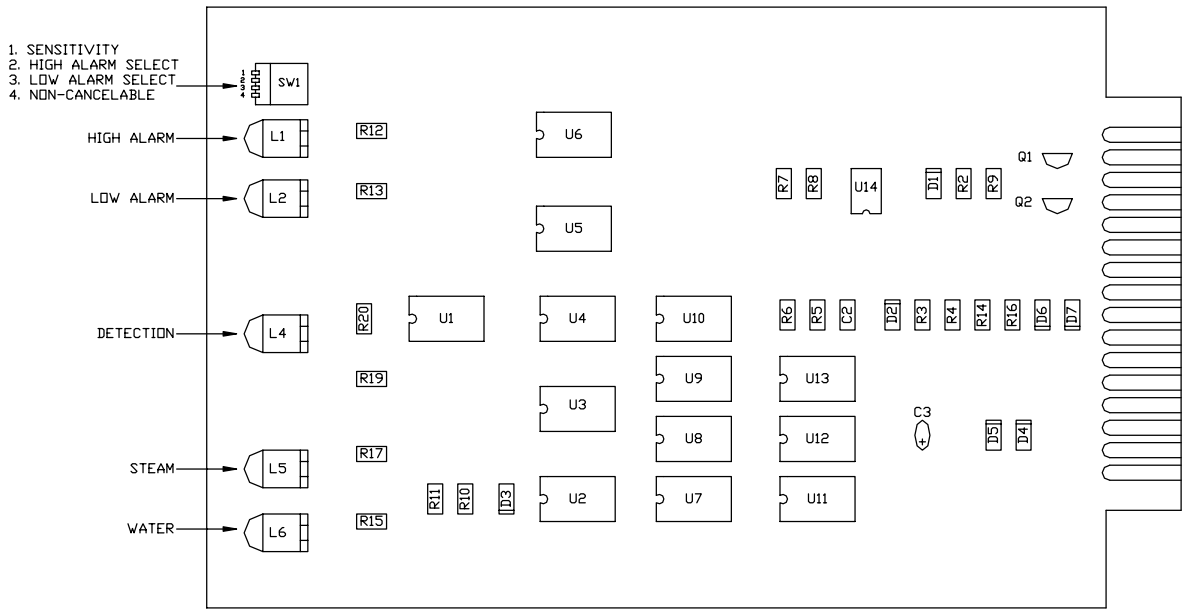


Figure 9 - System Monitor and D&V Jumper Settings

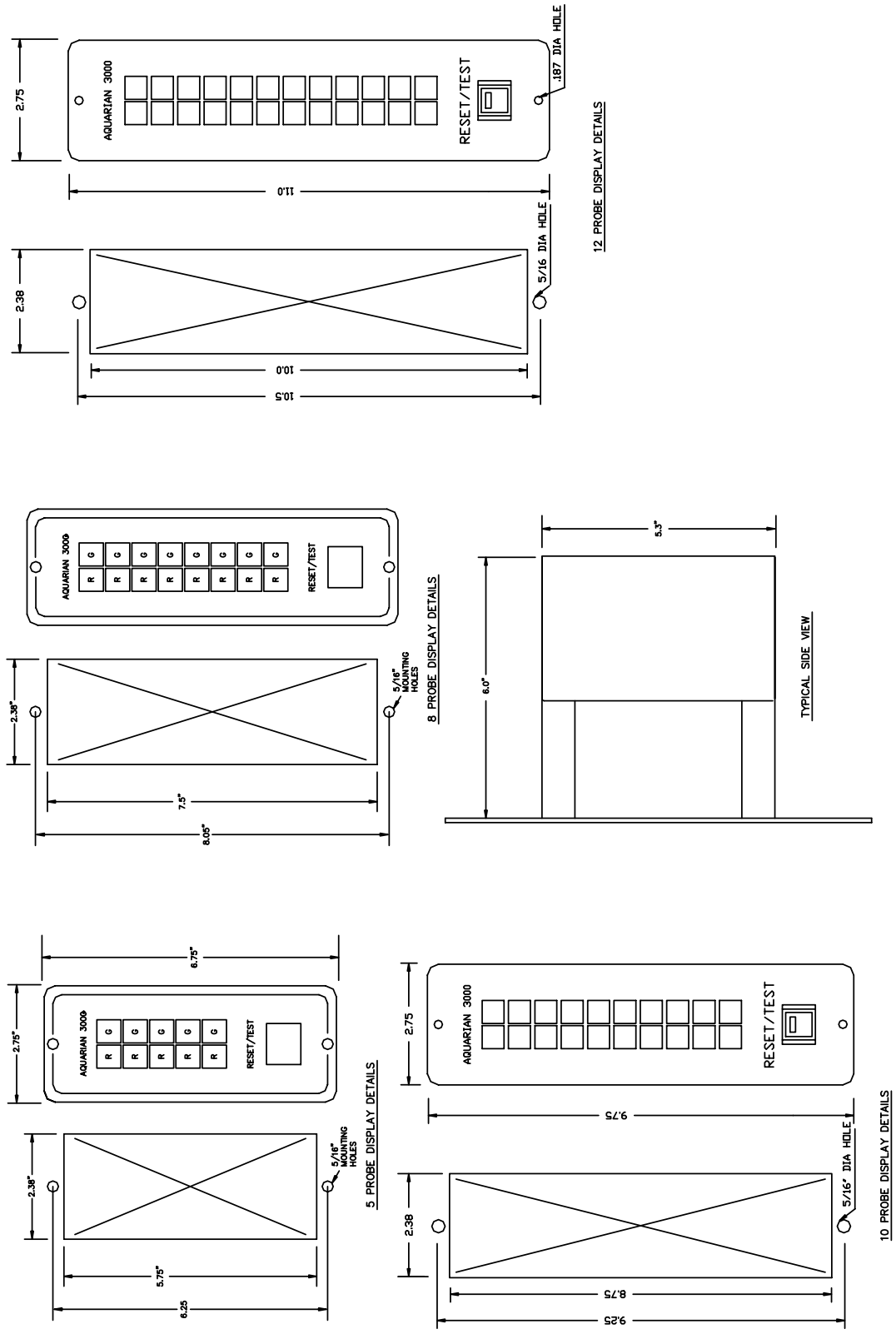


Figure 10 - Remote Display Options

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