



ARRAY BOILER (V2.5) APPLICATIONS GUIDE

RIELLO NORTH AMERICA

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RIELLO
Energy For Life

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Information in this document is supplemental to the Array Boiler Installation Manual, not in replacement. Intended as a demonstration of piping configurations concepts only and relevant parameters for the Array boilers. Drawings are not intended for construction. Project piping and trim requirements may vary; follow site specific requirements, engineering specifications, and local codes.

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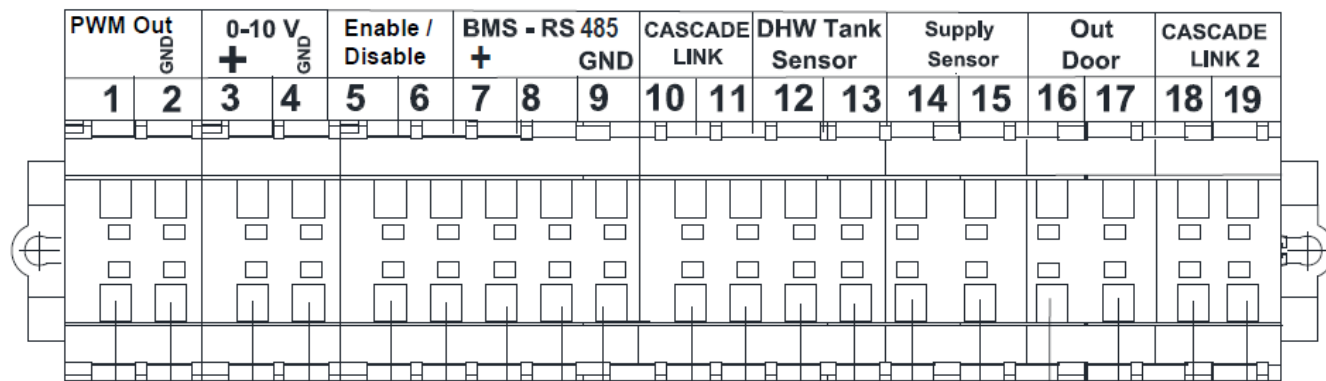
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1. General Wiring

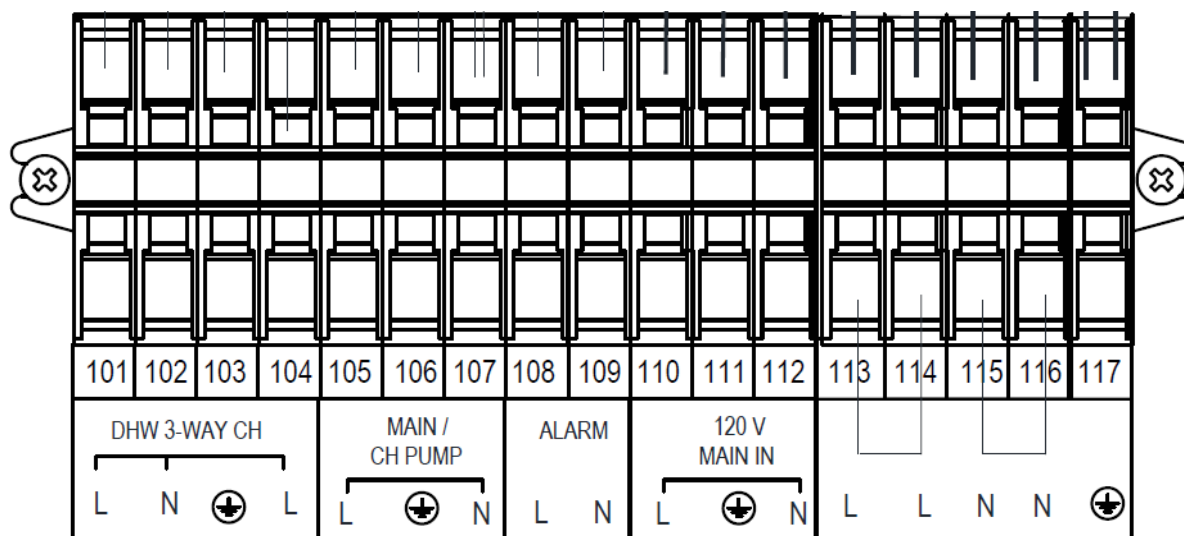
1. 1. AR399 – 500 TERMINALS

1. 1. 1. Low Voltage I/O Terminal Strip (AR399 – 500)



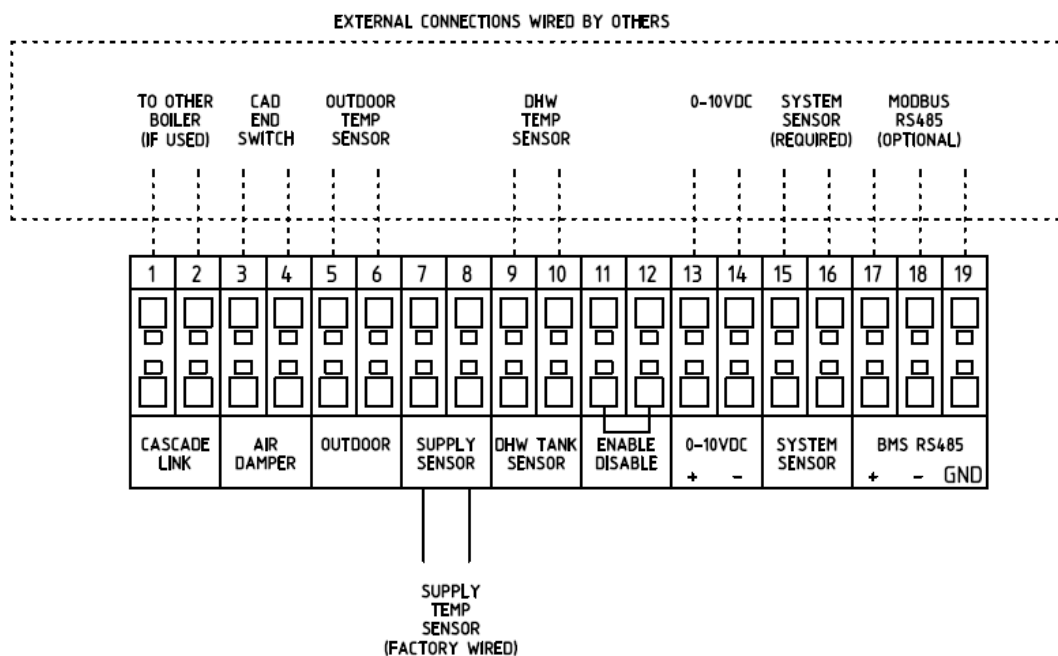
1. 1. 2. High Voltage Terminal Strip (AR399 – 500)

- Auxiliary outputs are 120V
- Relay duty only



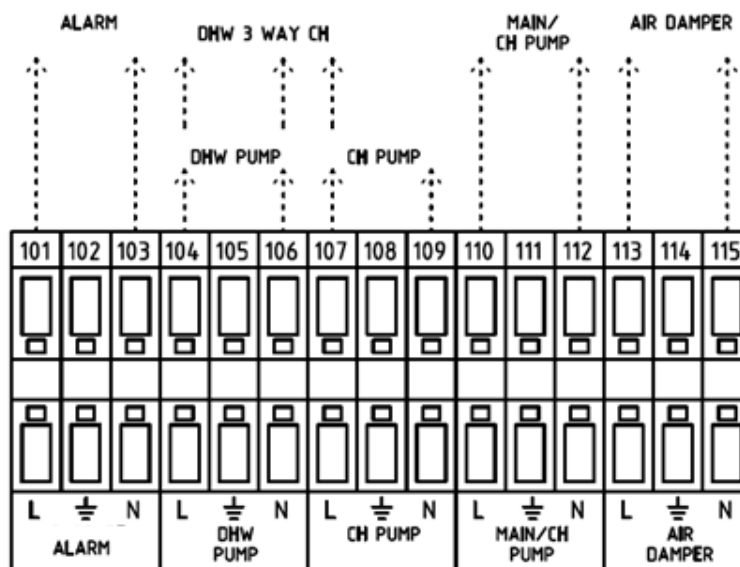
1. 2. AR800 – 4000 TERMINALS

1. 2. 1. Low Voltage I/O Terminal Strip (AR800- 4000)



1. 2. 2. High Voltage Terminal Strip (AR800- 4000)

- Auxiliary outputs are 120V
- Relay duty only



1. 3. Power Supply and Emergency Stop Placement

Note: E-stop, disconnect switch, and fuses by others.

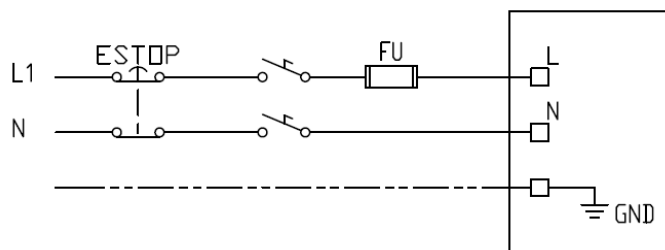
AR399

Voltage: 120V/1PH/60HZ

FLA: 6.0A

MOCP: 15A

MCA: 15A



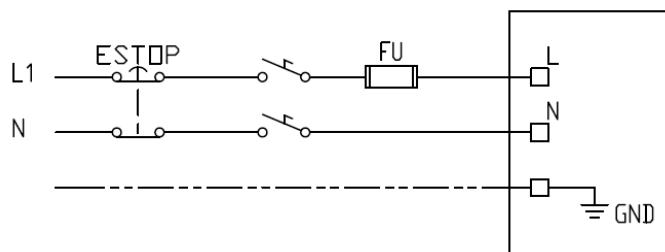
AR500

Voltage: 120V/1PH/60HZ

FLA: 7.5A

MOCP: 15A

MCA: 15A



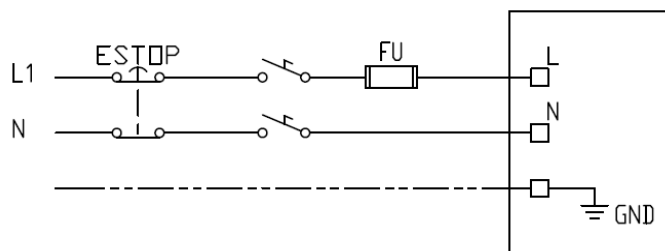
AR800

Voltage: 120V/1PH/60HZ

FLA: 15.5A

MOCP: 20A

MCA: 16A



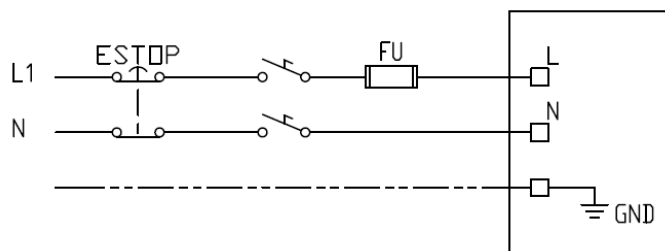
AR1000

Voltage: 120V/1PH/60HZ

FLA: 15.5A

MOCP: 20A

MCA: 16A



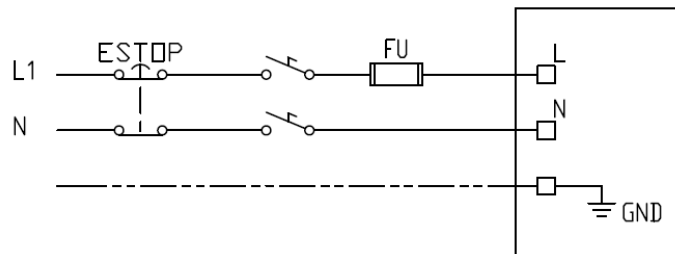
AR1500

Voltage: 120V/1PH/60HZ

FLA: 23.3A

MOCP: 30A

MCA: 24A



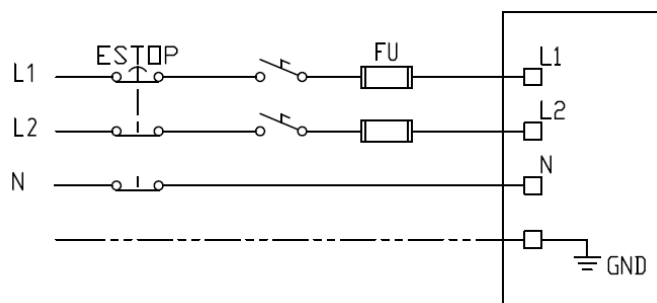
AR2000

Voltage: 240V/1PH/60HZ

FLA: 15.5A

MOCP: 20A

MCA: 16A



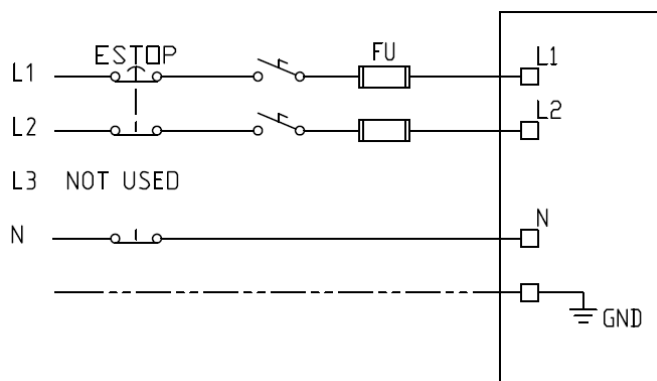
Voltage: Alternative

Using 2-legs of 208V/3PH/60HZ

FLA: 15.5A

MOCP: 20A

MCA: 16A



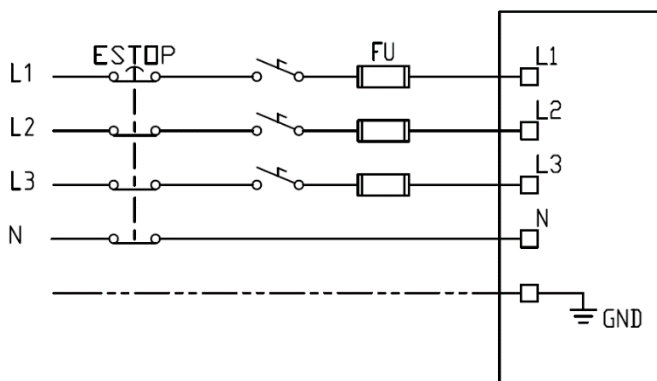
AR3000

Voltage: 208V/3PH/60HZ

FLA: 15.5A

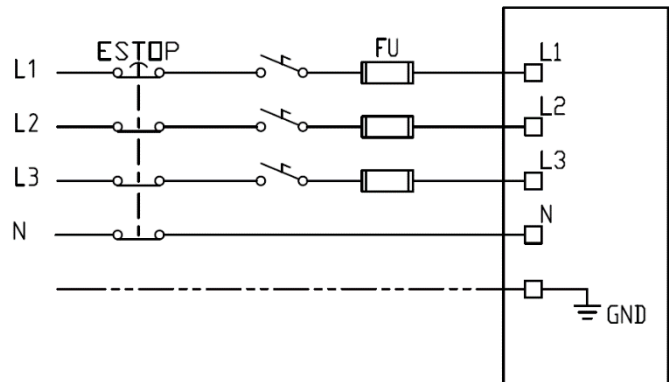
MOCP: 20A

MCA: 16A



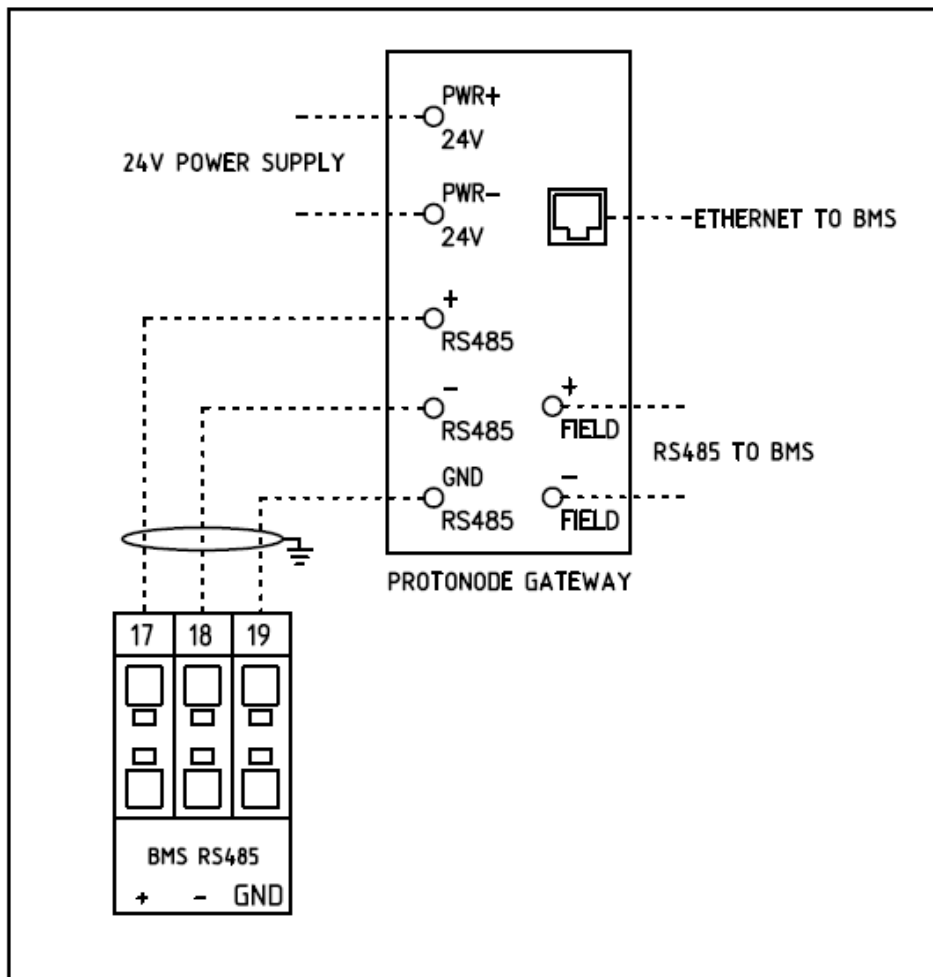
AR4000

Voltage: 208-230V/3PH/60HZ
FLA: 23.3A
MOCP: 30A
MCA: 24A



1. 4. Communication to Building Management System

WIRING FOR BACNET GATEWAY (IF USED)

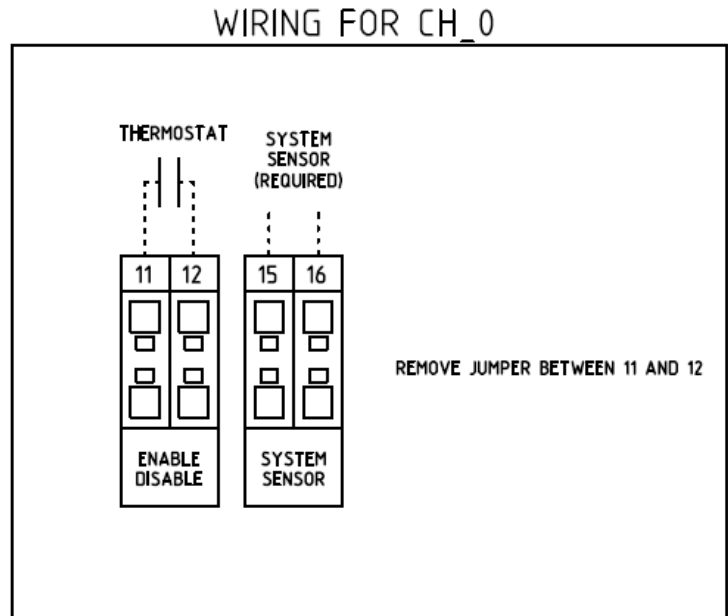


2. Operating Modes & Related Wiring

2.1. Central Heating Modes

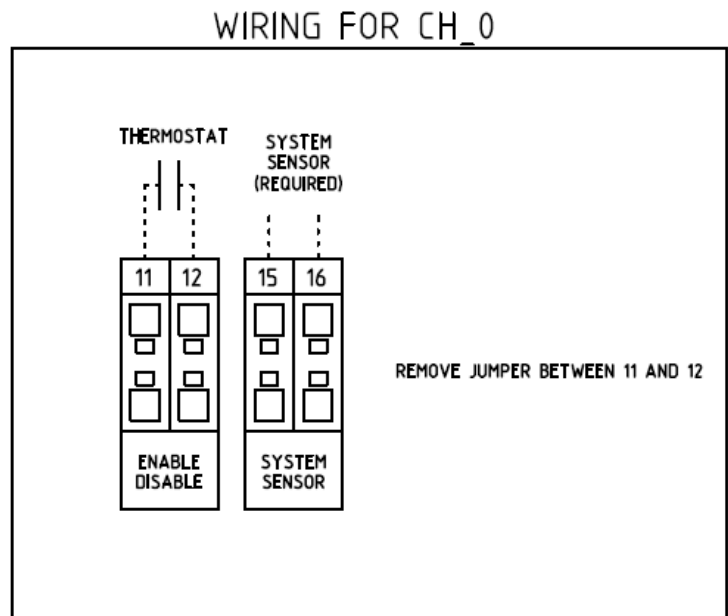
CH Mode 0 - Room Thermostat (Enable / Disable) – fixed setpoint

When the room thermostat closes, the system switches ON. Temperature Setpoint is manually set on the CH/DHW Setpoints screen (through the Settings screen).



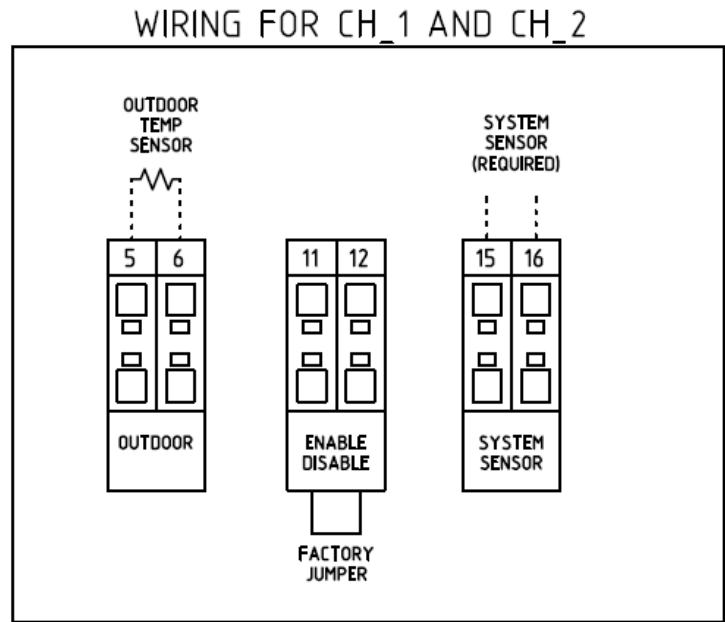
CH Mode 0 - Room Thermostat (Enable / Disable) – BMS controlled setpoint

BMS control activates the boiler when a dry contact closes, the system switches ON. Temperature Setpoint is written to the boiler register by BMS.



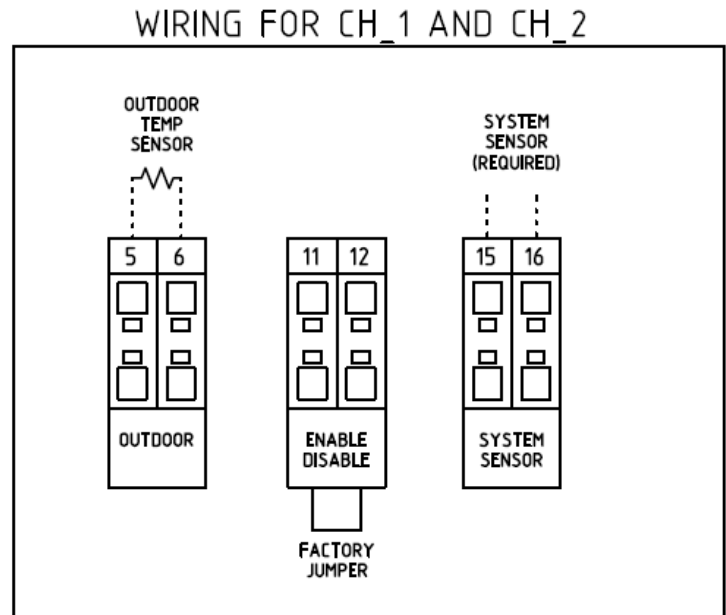
CH Mode 1 - Room Thermostat & Outdoor Reset

This mode requires an outdoor sensor, in addition to the room thermostat. The system functions like CH mode-0, except the **Temperature** Setpoint is automatically calculated based on the Reset curve.CH



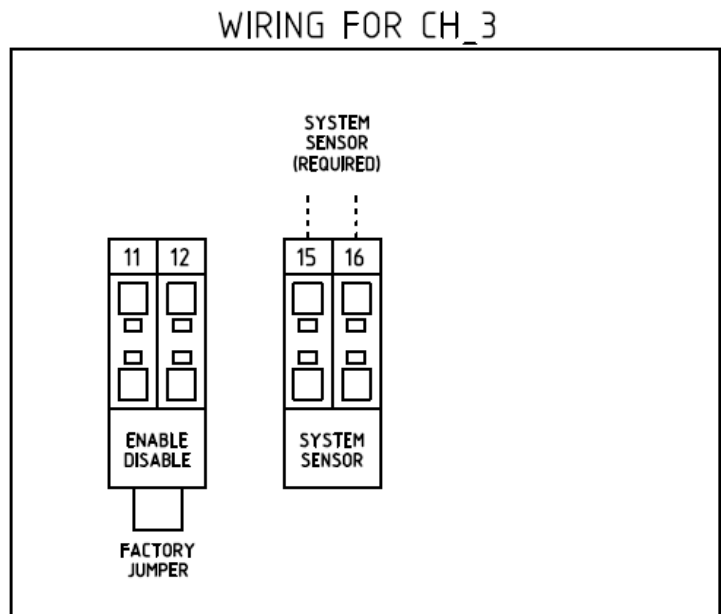
CH Mode 2 - Full Outdoor Reset

Just an outdoor sensor is required. The Temperature Setpoint is still automatically calculated based on the Reset curve. If a room thermostat is installed, it activates the Night setback function (setpoint reduction during the night) but it does not affect the CH demand.



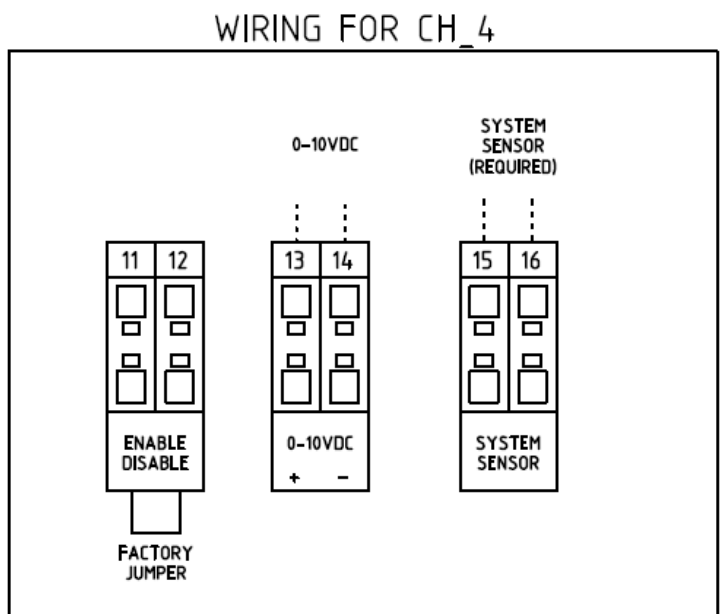
CH Mode 3 - Permanent Demand

The system works similarly to Mode 0. Supply temperature is kept at the Setpoint level steadily. If a room thermostat is installed, it activates the Night setback function (setpoint reduction during the night) but it does not affect the CH demand. Module pump is always ON.



CH Mode 4 - Analog Input to Setpoint

The Temperature Setpoint is given by an analog signal provided by a remote control such as a Building Management System or a system controller. A heat demand will be generated by an input of 1.5 Volts or higher. Modulation will occur between 2 and 9 Volts. Voltage below 1 Volt will shutoff any demand.



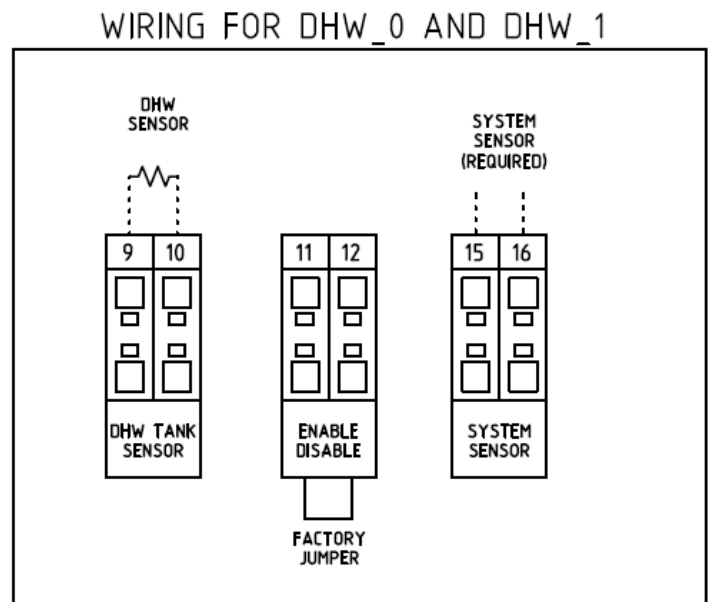
2. 2. Domestic Hot Water Modes (Select in Addition to CH Mode)

DHW Mode 0 - DHW Function Disabled

DHW Mode Disabled

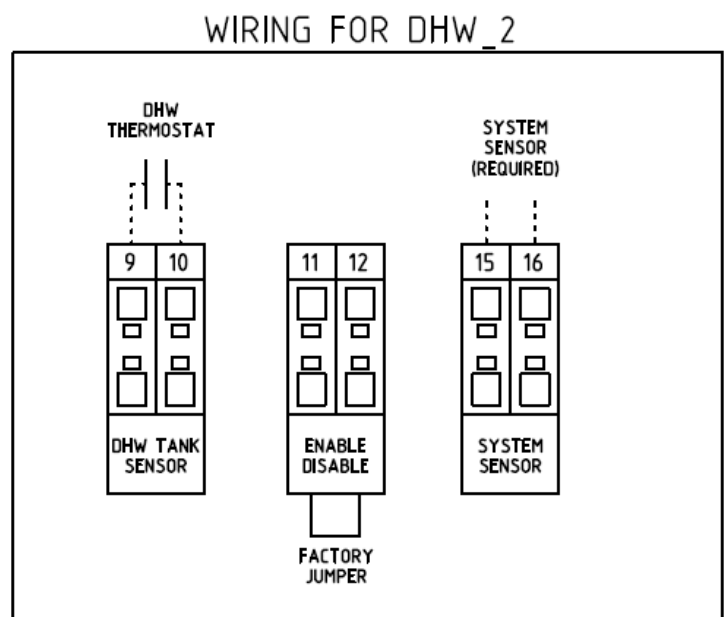
DHW Mode 1 - Tank with Sensor

Hot water is stored in a tank where the temperature is measured by a sensor. Either a pump or a 3-way valve can be used to switch to DHW mode. When the DHW demand is on, the boiler is PID modulated to achieve the supply temperature made by the DHW store setpoint increased by an adjustable extra temperature. DHW store setpoint is manually set on the CH/DHW Setpoints screen (through the Settings screen).



DHW Mode 2 - Tank with Thermostat

Hot water is stored in a tank where the temperature is detected by a thermostat (ON/OFF signal). Either a pump or a 3-way valve can be used to switch to DHW mode. When the DHW demand is on, the boiler is PID modulated to achieve the DHW store setpoint. DHW store setpoint is manually set on the CH/DHW Setpoints screen (through the Settings screen).



2. 3. Frost Protection Function

In cascade systems Frost Protection is active on 3 levels.

1. Boiler cascade controller (Multiple Array Boilers)
2. Burner cascade controller (Internal to 1 Array Boiler)
3. Burner (Individual Module)

The start temperatures should be defined so that the cascade handlers are the first to trigger the protection. When there is a CH/DHW call for heat, the frost protection will be overridden, and the control will start for CH/DHW. When frost protection stops the pumps go to post pump. The display may show “Frost protection” when activated.

2. 3. 1. Frost protection for boiler cascade

The ‘frost protection’ function for a boiler cascade is related to the system sensor temperature. When the system sensor temperature is:

Temp. < Cascade_Frost_Protection	The cascade CH / System pump and the general pump of the managing burner in the managing boiler start running.
--	--

2. 3. 2. Frost protection for burner cascade

The ‘frost protection’ function for a burner cascade is related to the boiler sensor temperatures. When the boiler sensor temperature or the managing burner supply/return temperature is below:

Temp. < Cascade_Frost_Protection	The cascade CH/system pump and the general pump of the managing burner start running.
--	---

Temp. < Cascade_Frost_Protection - 5°C	Cascade heat demand is activated to open the optional air damper; the general pumps of all the burners will be started. Demand with setpoint
--	--

Cascade_Frost_Protection Allows the burners to start burning until the lowest of both boilers, managing supply and return temperatures are above Cascade_Frost_Protection + 5°C.

2. 3. 3. Frost protection on burner

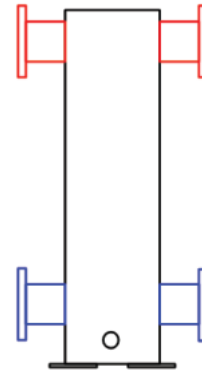
As last protection the controllers for the burners can force themselves to burn.

Note: On systems with an air damper this demand will not be served when the air damper is closed. If the burner supply/return temperature drops below 5°C (41°F) the burner starts at minimum power and continues burning until the lowest of both supply and return temperatures are above 15°C (59°F).

3. Piping Guidelines

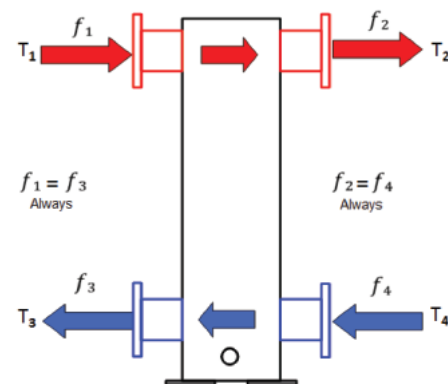
HYDRONIC SEPARATION

A hydronic separator connects (hydraulically separates) the boiler system (primary loop) and the heating loop (secondary loop). The cross section of the hydronic separator chamber is 2-3 times larger than the supply connection. For installations equipped with a hydronic separator, every pump works conflict free and independently from other pumps that are working at the same time; the heat supply will also adapt itself to the required heat load. Hydronic separators are great at separating air from the fluid and trapping sediment due to the low velocity in the chamber. The Array boiler must be installed with either a hydronic separator or appropriately design closely spaced tee's



BALANCED SYSTEM

This hydronic junction distribution of flow and temperature are equal between T1 - T2 and T3 - T4. This case is an exception, not the norm.



GREATER PRIMARY FLOW RATE

The flow on the primary side is greater than flow on the secondary side (i.e. when pumps shut down or zone valves close). Therefore, a part of the flow returns to the primary side with a higher temperature T_3 . With a higher temperature return water the boiler has to reduce its firing rate.

You can calculate the boiler return temperature T_3 by using the formula below.

$$T_3 = \left\{ \frac{(f_1 - f_2) T_1 + (f_4) T_4}{f_1} \right\}$$

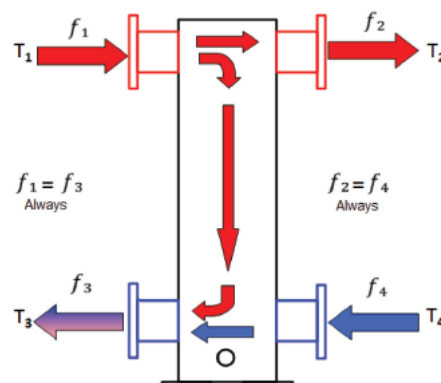
T_3 = Temperature of return water to boiler

f_1 = Flow rate entering from Primary side (gpm)

f_2, f_4 = Flow rate of the Secondary side (gpm)

T_1 = Temperature of fluid entering from Primary side

T_4 = Temperature of fluid returning from Secondary side

**GREATER SECONDARY FLOW RATE**

This hydronic separator distribution of flow and temperature are equal between $T_1 - T_2$ and $T_3 - T_4$. This case is an exception, not the norm.

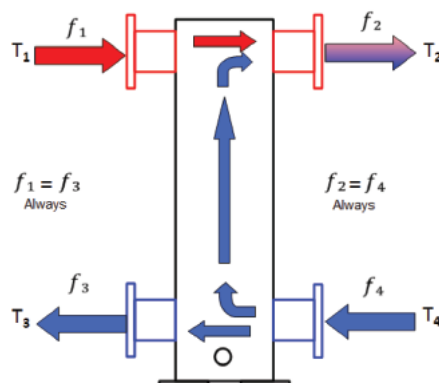
$$T_2 = \left\{ \frac{(f_4 - f_1) T_4 + (f_1) T_1}{f_4} \right\}$$

f_4 = Flow rate returning from Secondary side

f_1 = Flow rate entering from Primary side

T_4 = Temperature of fluid returning from Secondary side

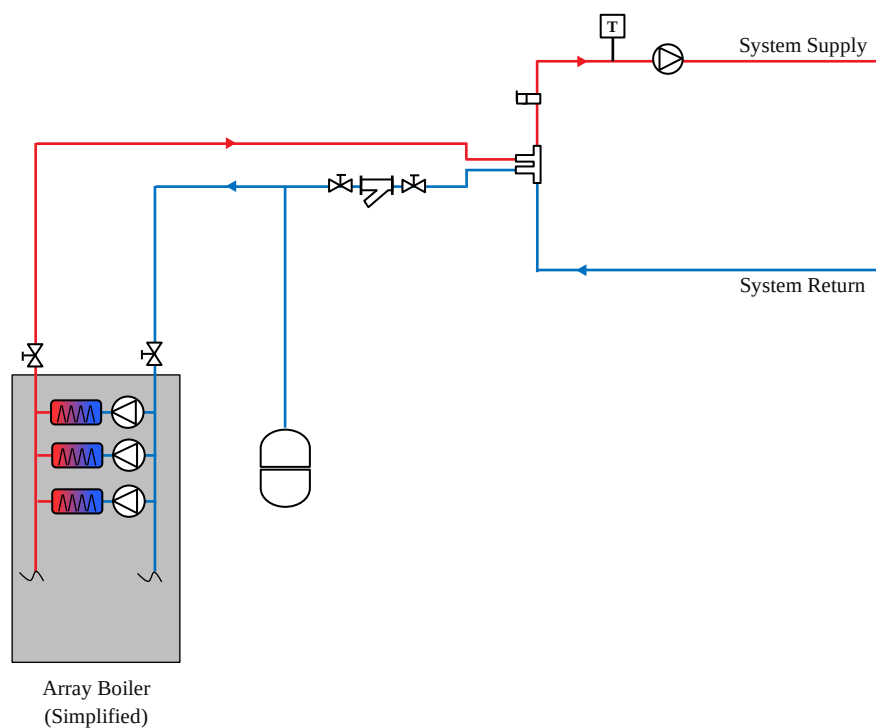
T_1 = Temperature of fluid entering from Primary side



- Size common boiler loop piping for 2-4 ft/second

3. 1. Single Array

3. 1. 1. Conceptual Layout



Not for construction

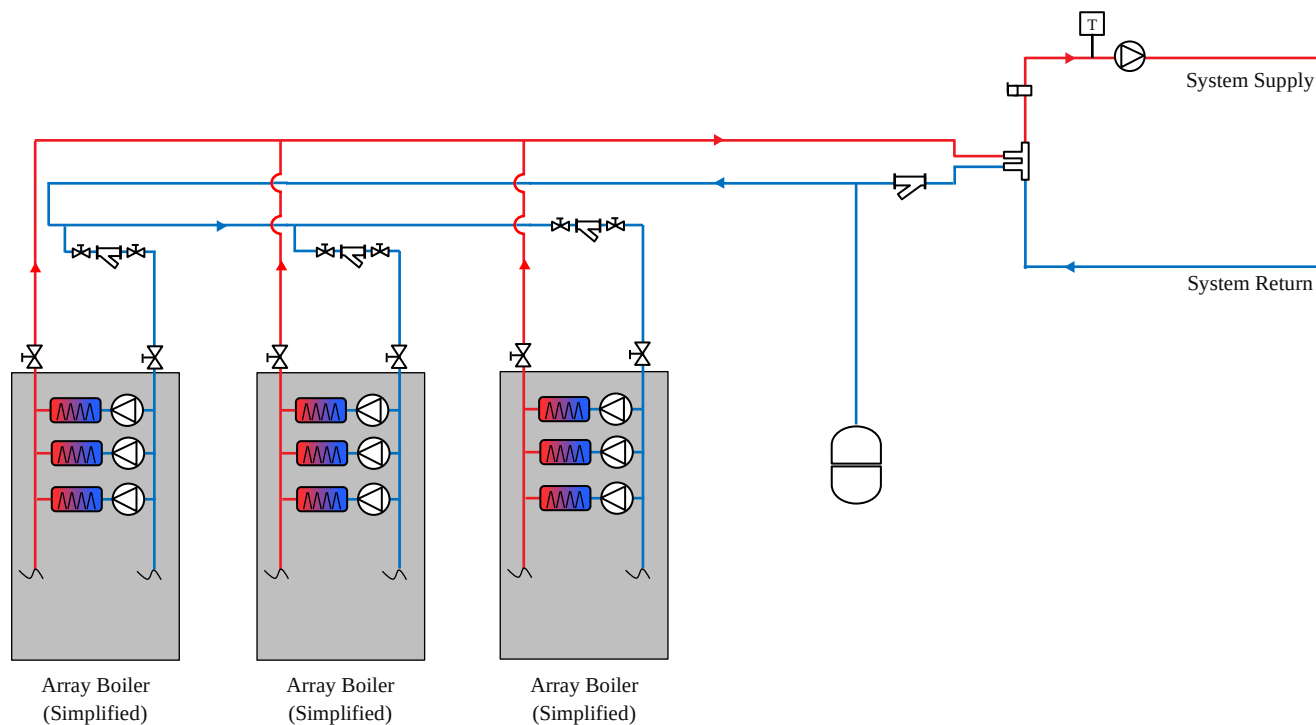
	Expansion Tank		Hydronic Separator / Closely spaced Tee's
	Isolation Valve		Pump
	Filter		Air eliminator
			Array Temperature Sensor

3. 1. 2. Key Parameters

Parameter	Range	Default	Description
(1) CH Mode	0 - 4	0	Defines CH Mode (See section 2.1)
(3) CH Setpoint	30...90 (86...194)	70 (158)	Defines system temperature setpoint
(127) Prog. Output 3.	0) Disabled 6) Alarm Relay 10) Air Damper 11) HSI / ext. igniter	0	Used to activate Air damper output/input. See also LPG conversion if converting fuel type.

3. 2. Multiple Arrays

3. 2. 1. Conceptual Piping Layout



Not for construction

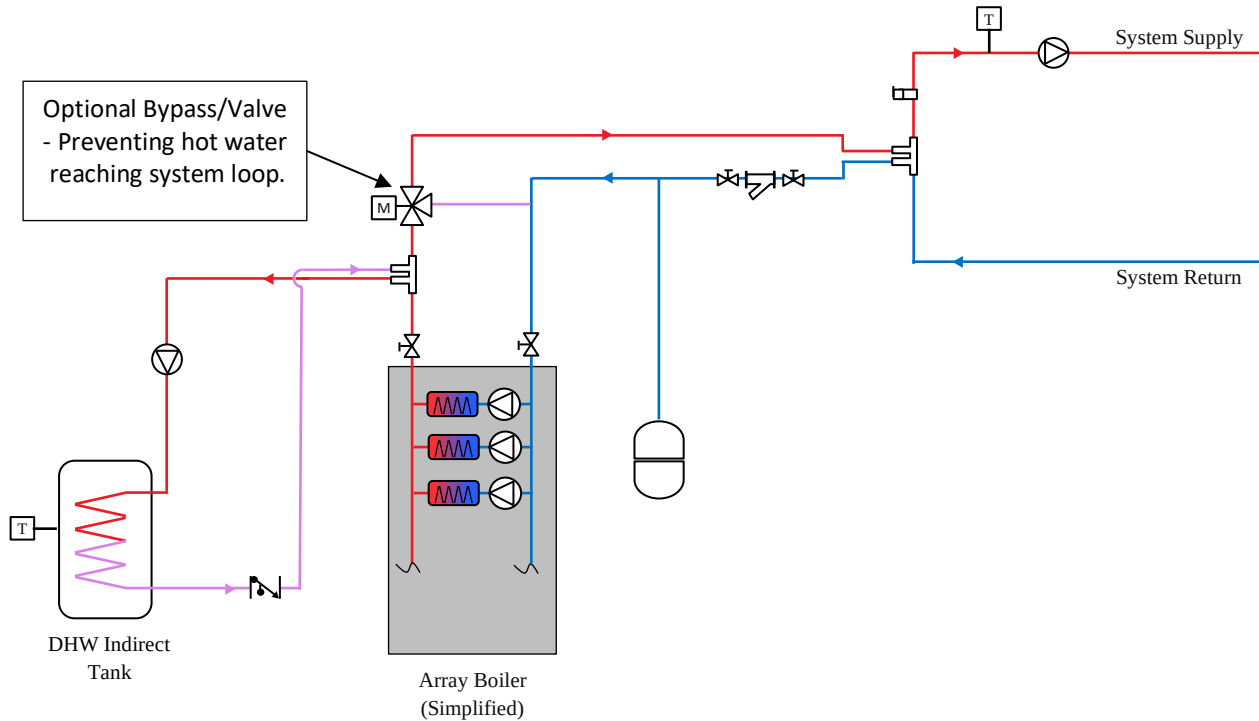
	Expansion Tank		Hydronic Separator / Closely spaced Tee's
	Isolation Valve		Pump
	Filter		Air eliminator
			Array Temperature Sensor

3. 2. 2. Key Parameters

Parameter	Range	Default	Description
(1) CH Mode	0 - 4	0	Defines CH Mode (See section 2.1)
(3) CH Setpoint	30...90 (86...194)	70 (158)	Defines system temperature setpoint
(127) Prog. Output 3.	0) Disabled 6) Alarm Relay 10) Air Damper 11) HSI / ext. igniter	0	Used to activate Air damper output/input. See also LPG conversion if converting fuel type.

3. 3. Single Array + Domestic Hot Water

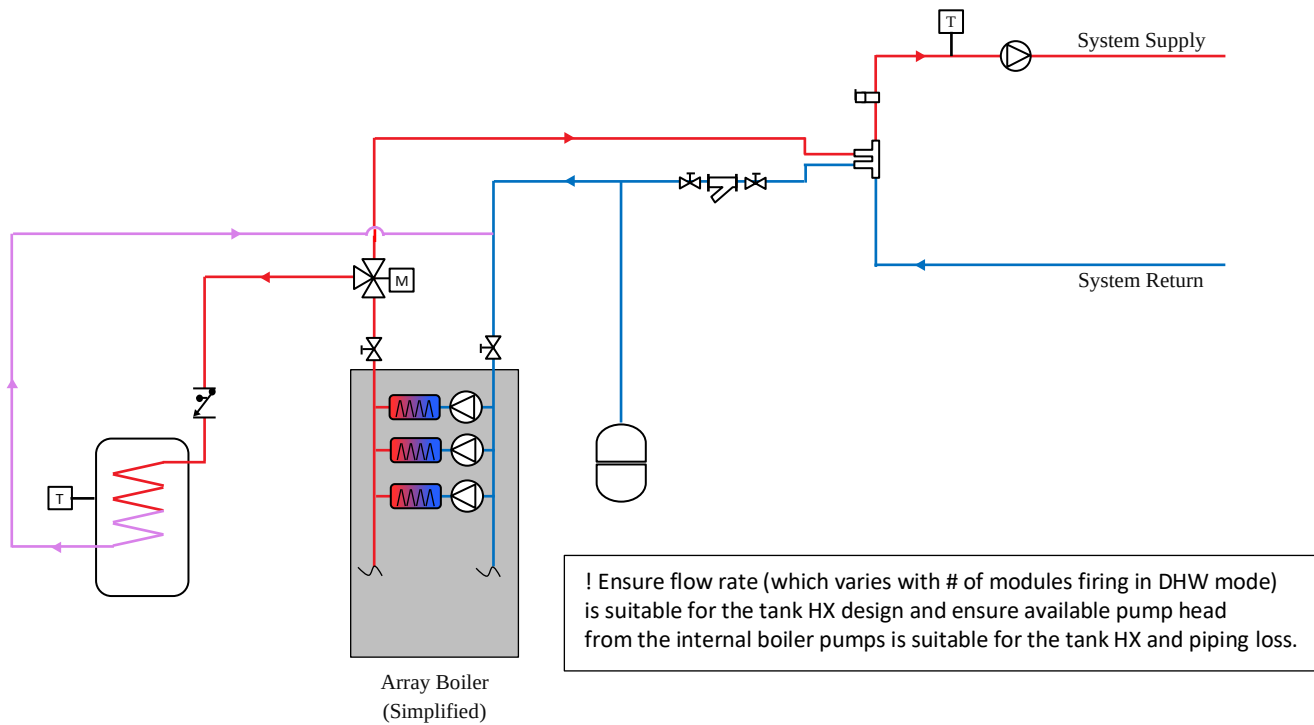
3. 3. 1. Conceptual Piping Layout – (A) Field Supplied DHW Pump



Not for construction

	Expansion Tank		Hydronic Separator / Closely spaced Tee's
	Isolation Valve		Pump
	Filter		Air eliminator
	Motorized three-way valve		Array Temperature Sensor
	DHW Tank		Check Valve

3. 3. 2. Conceptual Piping Layout – (B) No DHW Pump



Not for construction

	Expansion Tank		Hydronic Separator / Closely spaced Tee's
	Isolation Valve		Pump
	Filter		Air eliminator
	Motorized three-way valve		Array Temperature Sensor
	DHW Tank		Check Valve

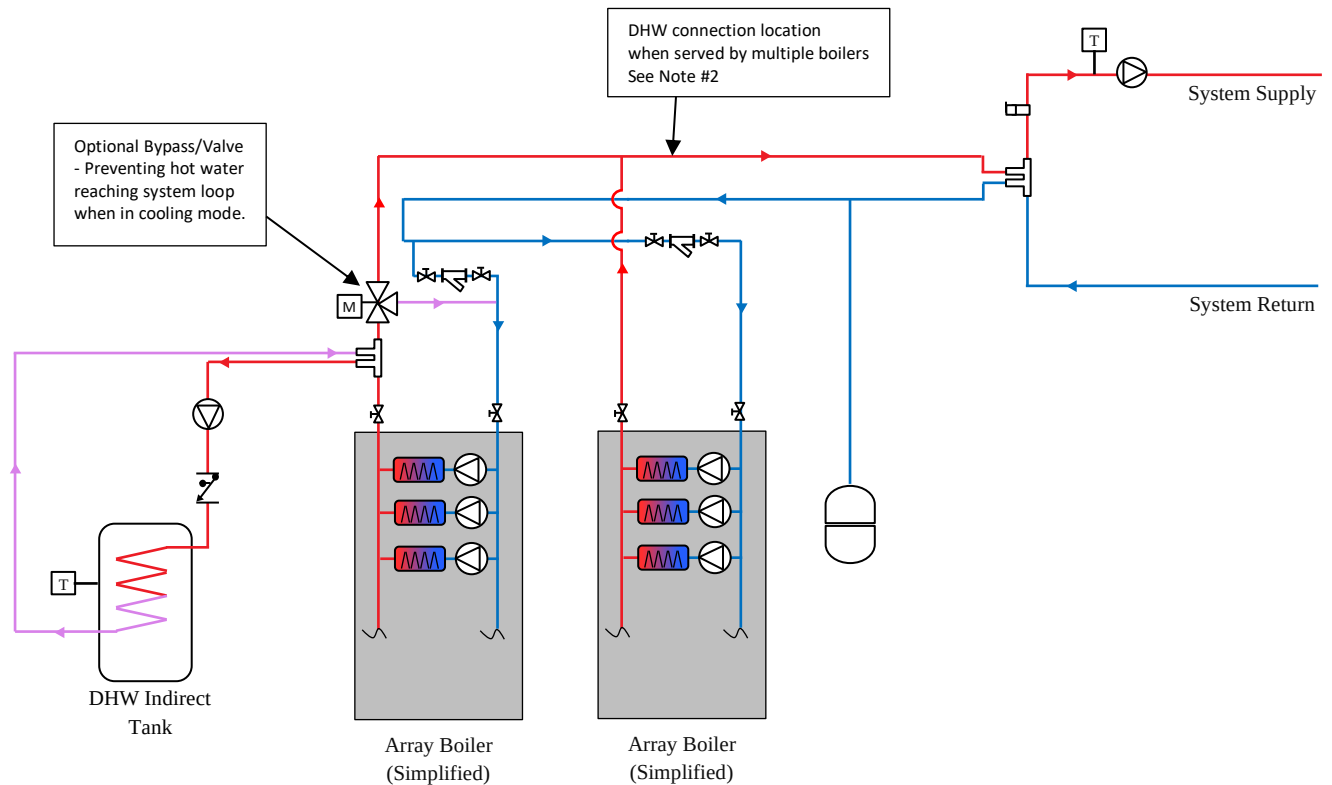
3. 3. 3. Key Parameters

In a **SINGLE BOILER** installation, the boiler automatically switches service between DHW and CH based on these priority parameters. It is also possible for CH and DHW loads to be served simultaneously by setting parameter (42) to [3] (for Parallel Operation). For parallel operation, CH setpoint Parameter (3), must be below “DHW Setpoint + DHW Extra” i.e. the sum of parameters (38)+(48), which is true in most cases.

Parameter	Range	Default	Description
(1) CH Mode	0 - 4	0	Defines CH Mode (See section 2.1)
(3) CH Setpoint	30...90 (86...194)	70 (158)	Defines system temperature setpoint
(127) Prog. Output 3.	0) Disabled 6) Alarm Relay 10) Air Damper 11) HSI / ext. igniter	0	Used to activate Air damper output/input. See also LPG conversion if converting fuel type.
(35) DHW Mode	0) Disabled 1) Storage tank with Sensor 2) Storage tank with thermostat	0	Defines DHW Mode type
(42) DHW Priority	0) Time 1) Off 2) On 3) Parallel	2	[0] Time = DHW has priority for an amount of time specified in parameter (43) [1] Off = CH always has priority [2] On = DHW always has priority [3] Parallel = DHW always has priority to CH. CH Pump can be started if CH setpoint is below DHW supply (DHW Setpoint + Extra)
(43) DHW Max Priority Time	1-255	30	Sets maximum time limit for DHW priority
(48) DHW Tank setpoint	40...71 (104...160)	50 (122)	Used to calculate the boiler outlet water temperature for DHW demand.
(115) DHW Store point	40...71 (104...160)	50 (122)	When using DHW mode (1) this parameter sets the tank storage temperature

3. 4. Multiple Arrays + Domestic Hot Water

3. 4. 1. Conceptual Piping Layout



Not for construction

	Expansion Tank		Hydronic Separator / Closely spaced Tee's
	Isolation Valve		Pump
	Strainer		Air eliminator
	Motorized three-way valve		Array Temperature Sensor
	Indirect DHW Tank		Check Valve

Note 1. If the DHW priority boiler loses cascade connection, it will revert to the emergency mode when in CH service and continue to serve DHW normally on DHW call for heat.

Note 2. For more multiple boilers to serve DHW, the managing boiler must also be a DHW boiler. The DHW connection and optional by-pass piping must be moved downstream of both boilers in the primary loop.

3. 4. 2. Key Parameters

In a **MULTIPLE ARRAY BOILER** installation, DHW and CH can be serviced simultaneously irrespective of the individual temperature requirements by setting one boiler to DHW priority (42)[2] and installing an automatic valve(s) to isolate (optional) the DHW priority boiler when in DHW service. After the DHW call-for-heat is satisfied, this boiler returns to CH service.

Managing Boiler

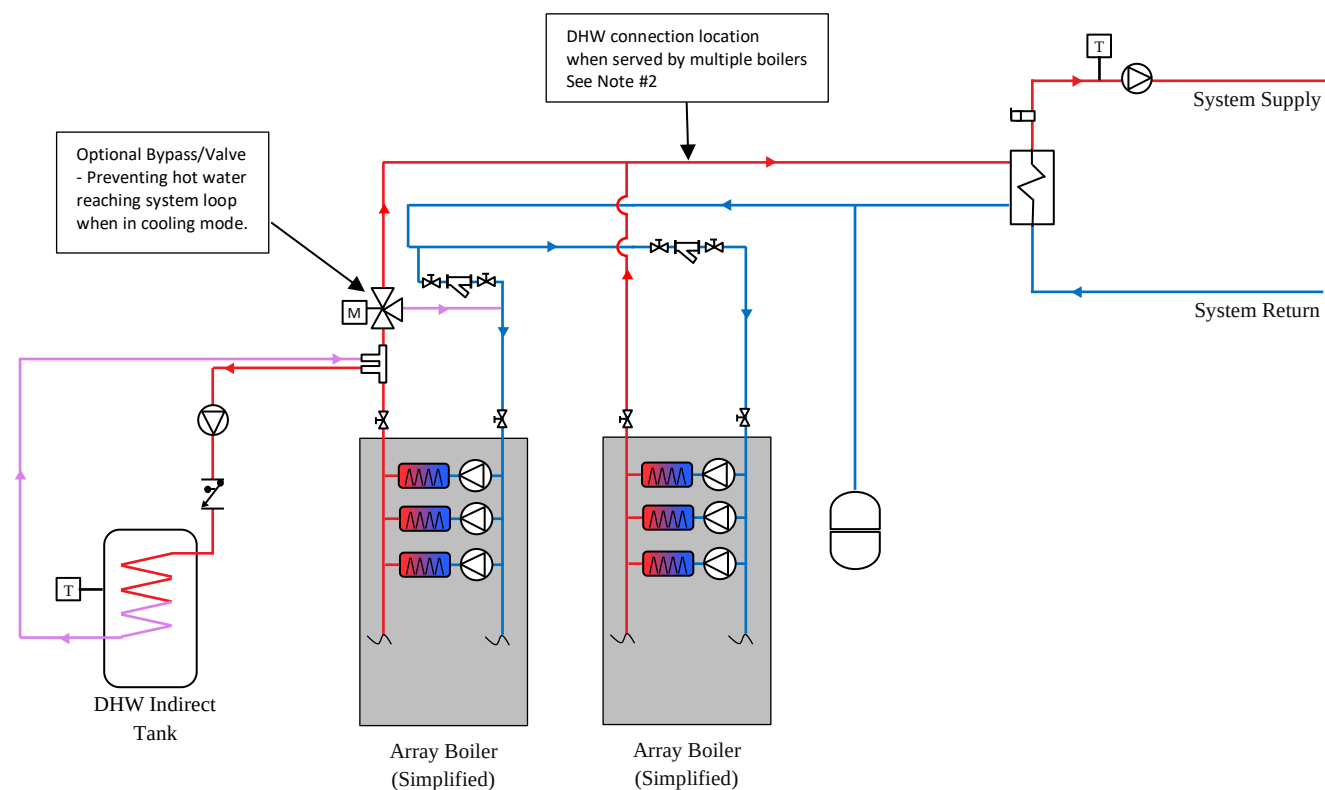
Parameter	Range	Default	Description
(1) CH Mode	0 - 4	0	Defines CH Mode (See section 2.1)
(3) CH Setpoint	30...90 (86...194)	70 (158)	Defines system temperature setpoint
(127) Prog. Output 3.	0) Disabled 6) Alarm Relay 10) Air Damper 11) HSI / ext. igniter	0	Used to activate Air damper output/input. See also LPG conversion if converting fuel type.

Dependent Boiler

(35) DHW Mode	0) Disabled 1) Storage tank with Sensor 2) Storage tank with thermostat	0	Defines DHW Mode type
(42) DHW Priority	0) Time 1) Off 2) On 3) Parallel	2	[0] Time = DHW has priority for an amount of time specified in parameter (43) [1] Off = CH always has priority [2] On = DHW always has priority [3] Parallel = DHW always has priority to CH. CH Pump can be started if CH setpoint is below DHW supply (DHW Setpoint + Extra)
(43) DHW Max Priority Time	1-255	30	Sets maximum time limit for DHW priority
(48) DHW Tank setpoint	40...71 (104...160)	50 (122)	Used to calculate the boiler outlet water temperature for DHW demand.
(115) DHW Store point	40...71 (104...160)	50 (122)	When using DHW mode (1) this parameter sets the tank storage temperature

3. 5. Multiple Arrays + System HX + Domestic Hot Water

3. 5. 1. Conceptual Piping Layout – Direct to HX



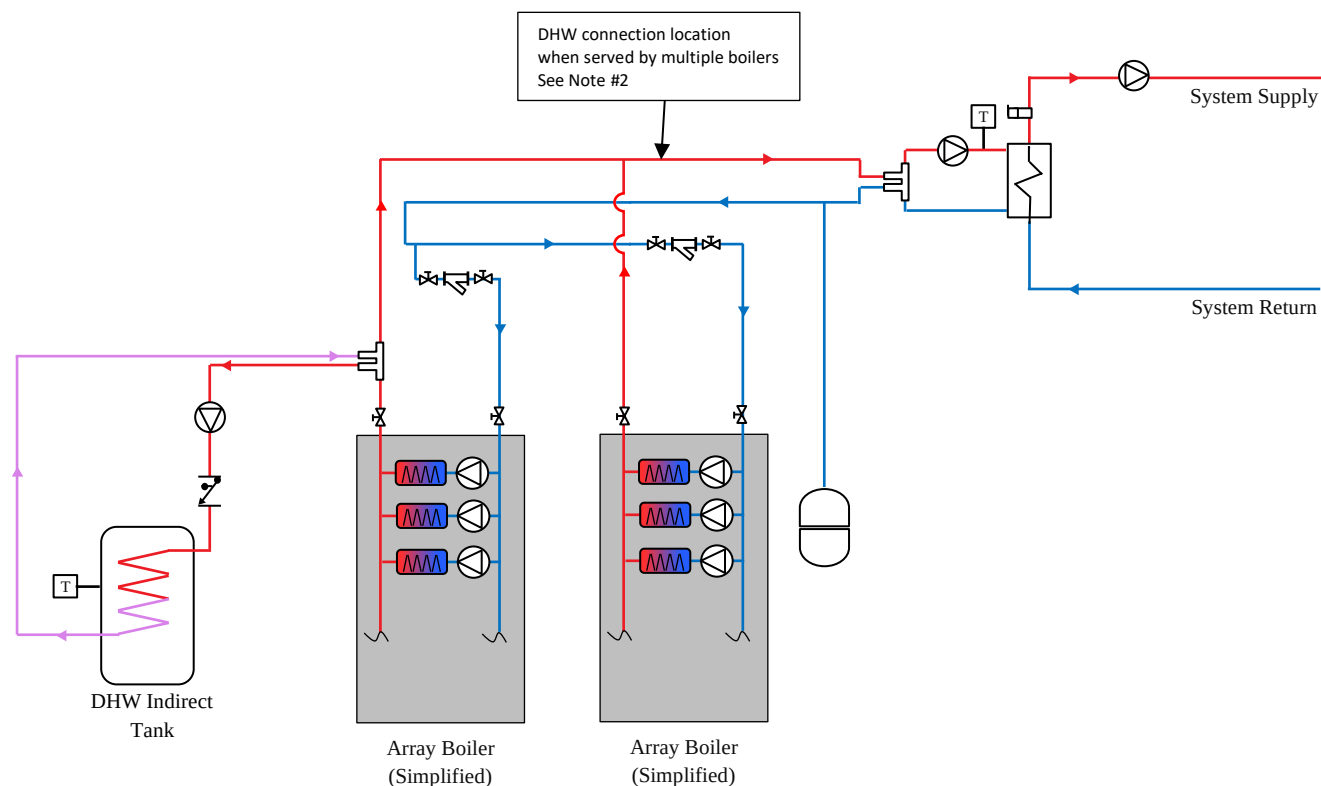
Not for construction

	Expansion Tank		Hydronic Separator / Closely spaced Tee's
	Isolation Valve		Pump
	Strainer		Air eliminator
	Motorized three-way valve		Array Temperature Sensor
	Indirect DHW Tank		Check Valve
	Heat Exchanger		

Note 1. If the DHW priority boiler loses cascade connection, it will revert to the emergency mode when in CH service and continue to serve DHW normally on DHW call for heat.

Note 2. For more multiple boilers to serve DHW, the managing boiler must also be a DHW boiler. The DHW connection and optional by-pass piping must be moved downstream of both boilers in the primary loop.

3. 5. 2. Conceptual Piping Layout – Intermediate Loop to HX



Not for construction

	Expansion Tank		Hydronic Separator / Closely spaced Tee's
	Isolation Valve		Pump
	Strainer		Air eliminator
	Motorized three-way valve		Array Temperature Sensor
	Indirect DHW Tank		Check Valve
	Heat Exchanger		

Note 1. If the DHW priority boiler loses cascade connection, it will revert to the emergency mode when in CH service and continue to serve DHW normally on DHW call for heat.

Note 2. For more multiple boilers to serve DHW, the managing boiler must also be a DHW boiler. The DHW connection and optional by-pass piping must be moved downstream of both boilers in the primary loop.

4. Domestic Hot Water Function

4. 1. DHW Tank Sensor or Thermostat

When DHW is used, a sensor or thermostat is installed in the indirect DHW tank (sensor installed to directly measure DHW temperature). This is in addition to the CH loop system sensor.

- a) DHW sensor is only used to determine if there is a call-for-heat (like a thermostat). The magnitude between measured temperature and set point does not affect the PID firing rate response.
- b) Using a sensor allows setting of a hysteresis band *electronically* through the boiler screen (this governs the DHW call-for-heat)
- c) Using a sensor, if measured DHW temperature is below (**DHW Setpoint – Hyst. Down**), then the auxiliary **DHW Pump** output and the internal module pump(s) allowed for DHW service are started.

If **Boiler Outlet** is below **Boiler Setpoint** (DHW Setpoint + Extra), the boiler will fire. Demand for DHW ends when DHW temperature is above (**DHW setpoint + Hyst. Up**).

- d) The “store warm” function, **Parameter (115)** – boiler level, is only available using a DHW sensor. This which brings on one module whenever DHW temperature drops below setpoint but still above the (DHW set-point) minus (hysteresis-down). This may serve to prevent activating a full DHW call-for-heat during instances of small loads and helps maintain steady DHW temperature while reducing boiler ramp-up cycling.

4. 2. Matching DHW Response to System Characteristics

! When DHW call-for-heat is activated, the Boiler Setpoint becomes: **DHW_SETPOINT + DHW_EXTRA !**

Increasing “DHW Tank Supply Extra” increases the rate of heat transfer through the DHW heat exchanger. This is the key parameter for matching boiler supply to DHW system load / characteristics.

Parameter (38) “DHW Tank Supply Extra” - Boiler Level

Parameter (48) “DHW/Tank Setpoint” - Boiler Level

Parameter (36) “DHW Tank Hyst. Down” - Boiler Level

Parameter (37) “DHW Tank Hyst. Up” - Boiler Level

The boiler works to meet this modified boiler setpoint in the exact same way it that it targets boiler setpoint when in CH mode. By cascading modules and in turn, modules controlling their own firing rate. Note that power balancing and cascade settings apply to the boiler across both service modes ‡

‡ **Parameter (184) “N. active burner for DHW” - Module Cascade Settings**

This parameter (184) sets the number of modules per boiler available for DHW. When this parameter is set to [1] module, then parameters (113) and (114) become active; †

(113) Max. power DHW [%] – Boiler Level

(114) Min. power DHW [%] – Boiler Level

These parameters (113) & (114) are activated when only one (1) module is selected for DHW service. In which case these are the upper and lower firing rate limits of that module. Otherwise (with more than 1 module in DHW mode) these parameters are voided and the internal PID and power balancing controls the cascade / firing characteristics.

† If Parameter (189) “DHW for All” – System Level is set to [YES] then parameter (184) determines number of boilers for DHW use, not individual modules.

In a **MULTIPLE BOILER system** with parameter (189) set to [YES], parameter (184) determines the number of BOILERS available for DHW.

In a **SINGLE BOILER / or MULTIPLE BOILER system** this parameter (189), if set to [YES] sets all MODULES available for DHW. If set to [NO] then parameter (184) determines No. of DHW service modules.

4. 3. DHW Priority Parameters

When operating in a DHW mode, the boiler retains a separate set-point for each system (DHW and CH). These are set by the user. Parameters determine which system has priority and for how long.

Parameter (42) “DHW Priority” - Boiler Level

Options: [0] Time = DHW has priority for an amount of time specified in parameter (43)
 [1] Off = CH always has priority
 [2] On = DHW always has priority
 [3] Parallel = DHW always has priority to CH. CH Pump can be started if CH setpoint is below DHW supply (DHW Setpoint + Extra)

Parameter (43) “DHW Max Priority Time” - Boiler Level

Range: [1-255] minutes

Priority time begins counting when both demands are present. DHW service will start upon DHW demand. It will end after DHW priority time and then CH will start. CH will run for an equal amount of time before switching back to DHW.

5. Vent Adapters

When using any of the UL® approved venting systems, follow the instructions provided with the venting for assembly in addition to section 4.15 *Venting* of the Array Installation and Operation Manual. All requirements in the boiler Installation and Operation Manual must be followed.

Suitable Venting: CPVC, PP, Stainless Steel, or AL29-4C, UL approved, positive pressure, watertight vent materials **MUST** be used for safety and UL® certification.

Installation must comply with local requirements and national codes:

USA: NFPA 54 / ANSI Z223.1 National Fuel Gas Code or the International Fuel Gas Code.

Canada: CAN/CGA-B149.1 Natural Gas Installation Code or CAN/CGA149.2 Propane Installation Code

Table 1: Exhaust Vent Adapters

	AR 800	AR 1000	AR 1500	AR 2000	AR 3000	AR 4000
Nominal Size:	6"			8"	8" or 10"	
Available through Riello or vent supplier						
CPVC	20135826*			20135827*	20135827 (8")* 20135828 (10")*	
Centrotherm®	Adapter not Required			Adapter not Required	Adapter not Required	
Heatfab®	20125456			20125457	20125457 (8") 20125429 (10")	
Available through vent supplier only						
Metal-Fab®	6FCMA			8FCSPKA	8FCSPKA (8") 10FCSPKA (10")	
Z-Vent®	2ZVARA6			2ZVARA8	2ZVARA8 (8") 2ZVARA10 (10")	
Schebler®	EVD-AKRAR-06R			EVD-AKRAR-08R	EVD-AKRAR-08R (8") EVD-AKRAR-10R (10")	
Duravent® Double Wall	SSD6MM161			SSD8MM201	SSD8MM201 (8") SSD10MM251 (10")	
Duravent® Single Wall	SS6MM161			SS8MM201	SS8MM201 (8") SS10MM251 (10")	

*Sold through Riello only.

Table 2: Ducted Air Inlet Adapters

	AR 800	AR 1000	AR 1500	AR 2000	AR 3000	AR 4000
Nominal Size:	6"			8"	10"	
Available through Riello						
PVC / CPVC	20165010			20165013	20165015	
Available through vent supplier only						
Z-Flex®	2ZDARA6A			2ZDARA8A	2ZDARA10A	