ASCEND® On-Demand Water Heater Installation, Operation and Maintenance Manual

WHAT TO DO IF YOU SMELL GAS:

- Do not try to light any appliance
- Do not touch any electrical switch
- Do not use any phone in your building

Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier instructions. if you cannot reach your gas supplier, call the fire department.

WARNING!

If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or death.

WARNING!

These appliances MUST be installed by a properly licensed individual in the City and State which the unit is being installed. All start up adjustments and subsequent service work must be done by a similarly licensed contractor or a factory trained service individual. Failure to comply could result in loss of warranty and or severe personal injury, death and or substantial property damage. **These instructions are required to be kept with the appliance on the left side, in the pocket provided.**

SCAQMD
Compliant Rule 1146.2

ANSI Z21.10.3/CSA 4.3-2019,
ANSI Z21.13/CSA 4.9-2017,
UL 795-2016, CGA 3.4-2020

Please read and save these instructions.

IOM-398

Armstrong®

Using the Manual

Throughout this manual you will see these special attention boxes similar to those below, which are intended to supplement the instructions and make special notice of potential hazards. These categories are in the judgment of the Manufacturer.

DANGER!

Indicates a condition or hazard which MAY cause severe personal injury, death, or major property damage.

CAUTION!

Indicates a condition or hazard which MAY cause severe personal injury, death, or major property damage.

WARNING!

Indicates a condition or hazard which MAY cause severe personal injury, death, or major property damage.

WARNING!

- THE VENT SYSTEM IS RATED AND DESIGNED TO BE 2 PIPE SEALED COMBUSTION ONLY, POLYPROPyIENE (PP), PVC SCH 40 OR CPVC SCH 40 OR 80 OR AL 29-4C STAINLESS VENTING FOR ALL MODELS. A FACTORY ENGINEERED VENTING SYSTEM MAY ALLOW FOR EXCEPTIONS; CONSULT FACTORY FOR DETAILS.
- THIS APPLIANCE INSTALLATION MUST CONFORM TO THE LATEST EDITION OF THE “NATIONAL FUEL GAS CODE” ANSI Z223.1 NFPA 54 AND/OR CAN/CGAB149 INSTALLATION CODES. STATE AND LOCAL CODES MIGHT ALSO APPLY TO INSTALLATION.
- WHERE REQUIRED BY THE AUTHORITY HAVING JURISDICTION, THE INSTALLATION MUST CONFORM TO THE STANDARDS FOR CONTROLS AND SAFETY DEVICES FOR AUTOMATICALLY FIRED APPLIANCES, ANSI/ASME APPLIANCE AND PRESSURE VESSEL CODE, SECTION IV, ALONG WITH CSD-1.
- THE APPLIANCE, GAS PIPING, WATER PIPING, VENTING AND ELECTRICAL MUST BE INSTALLED BY TRAINED & QUALIFIED PERSONNEL FAMILIAR WITH INSTALLATION PRACTICES, LOCAL CODE, AND LICENSING REQUIREMENTS.
- IF THE INFORMATION IN THESE INSTRUCTIONS ARE NOT FOLLOWED EXACTLY, A FIRE OR EXPLOSION MAY RESULT, CAUSING PROPERTY DAMAGE, PERSONAL INJURY, OR DEATH.
- DO NOT STORE OR USE GASOLINE OR OTHER FLAMMABLE VAPORS AND LIQUIDS IN THE VICINITY OF THIS OR ANY OTHER APPLIANCE.

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1.0 - General Information

1.1 - How ASCEND® Operates

The appliance product line is a high efficiency water heating product, requiring special venting and condensate removal precautions. All high efficiency condensing appliances will require more maintenance (cleaning) than their non-condensing counterparts. Failure to do so may result in damage to the appliance that is not covered under warranty. Failure to follow all of the instructions contained in this manual may also cause premature product failure that may not be covered under warranty.

This appliance has built-in freeze protection, automatically activating the circulation pump when the internal water temperature drops below 41°F. If the internal water temperature drops to 37°F, a burn cycle will be initiated and will shut down as soon as the supply water temperature has reached 50°F. **Power and gas must be left on for this function to operate.**

The appliance's primary controller is the HOT™ control platform. The HOT™ controller uses BCB and BDB boards to operate all functions of needed control and safety. It contains sophisticated logic that allows it to operate at very precise temperatures while minimizing burner on/off cycling. When multiple units are operated as a Cascade to handle a common load, the control logic contains the ability to control all of the units as efficiently as one. Cascade operation is a factory-installed and programmed option, requiring a field wiring connection between appliances for operation.

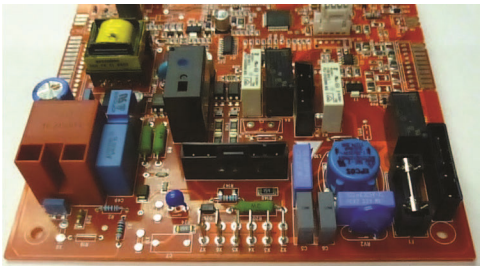
Key Terms

BCB Internal Boiler Control Board

BDB Boiler Display Board; human interface

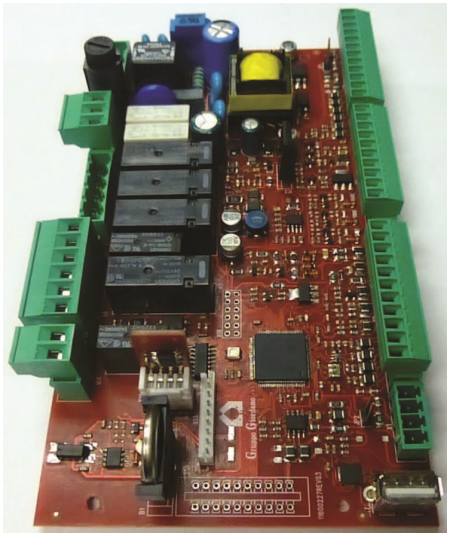
CCB Internal Cascade Control Board

CDB Cascade Display Board, human interface located in the face of the cabinet



BCB Boiler Control Board

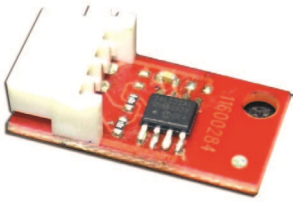
BDB Boiler Display Board

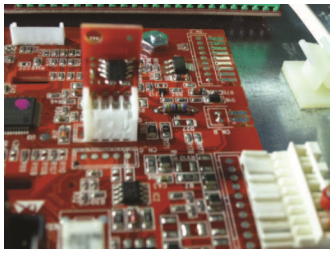


CCB Cascade Control Board

CDB Cascade Display Board

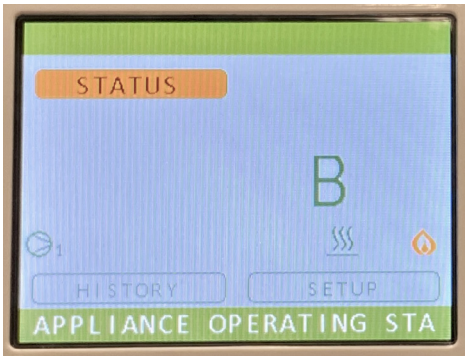
General Information, cont.



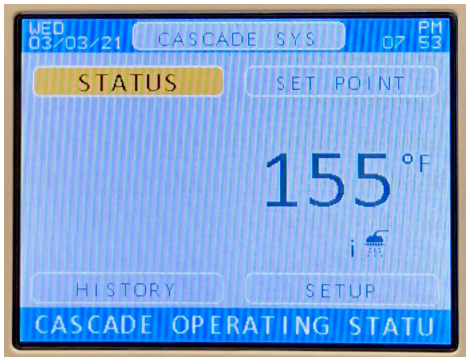


EDB Eeprom Data Board - contains all operating parameters of CCB and BCB

TYPICAL APPLIANCE DISPLAY AS PART OF A CASCADE

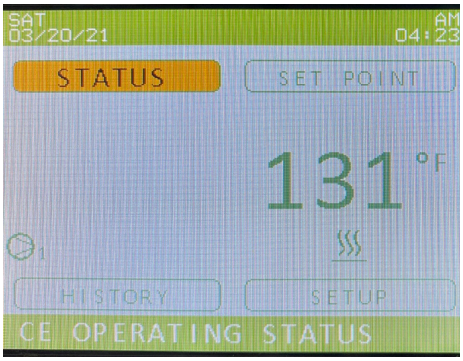


TYPICAL CASCADE DISPLAY



Typical Cascade display - Heating and Indirect Hot Water applications

TYPICAL STANDALONE APPLIANCE DISPLAY



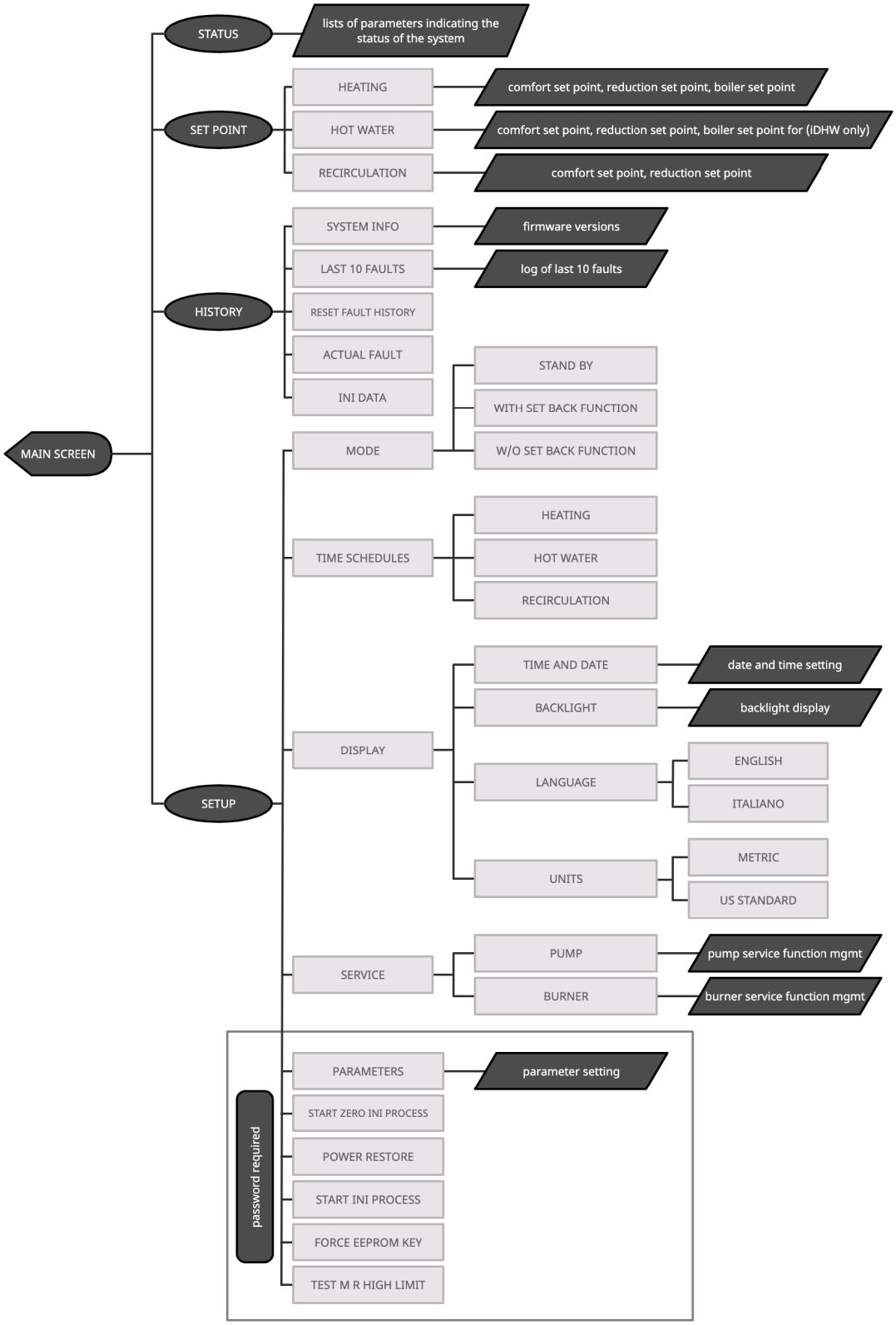
Typical standalone appliance display - Heating and Indirect Hot Water applications

The bottom of the display contains a scrolling message related to the current status of the system (Cascade Display), or the appliance

General Information, cont.

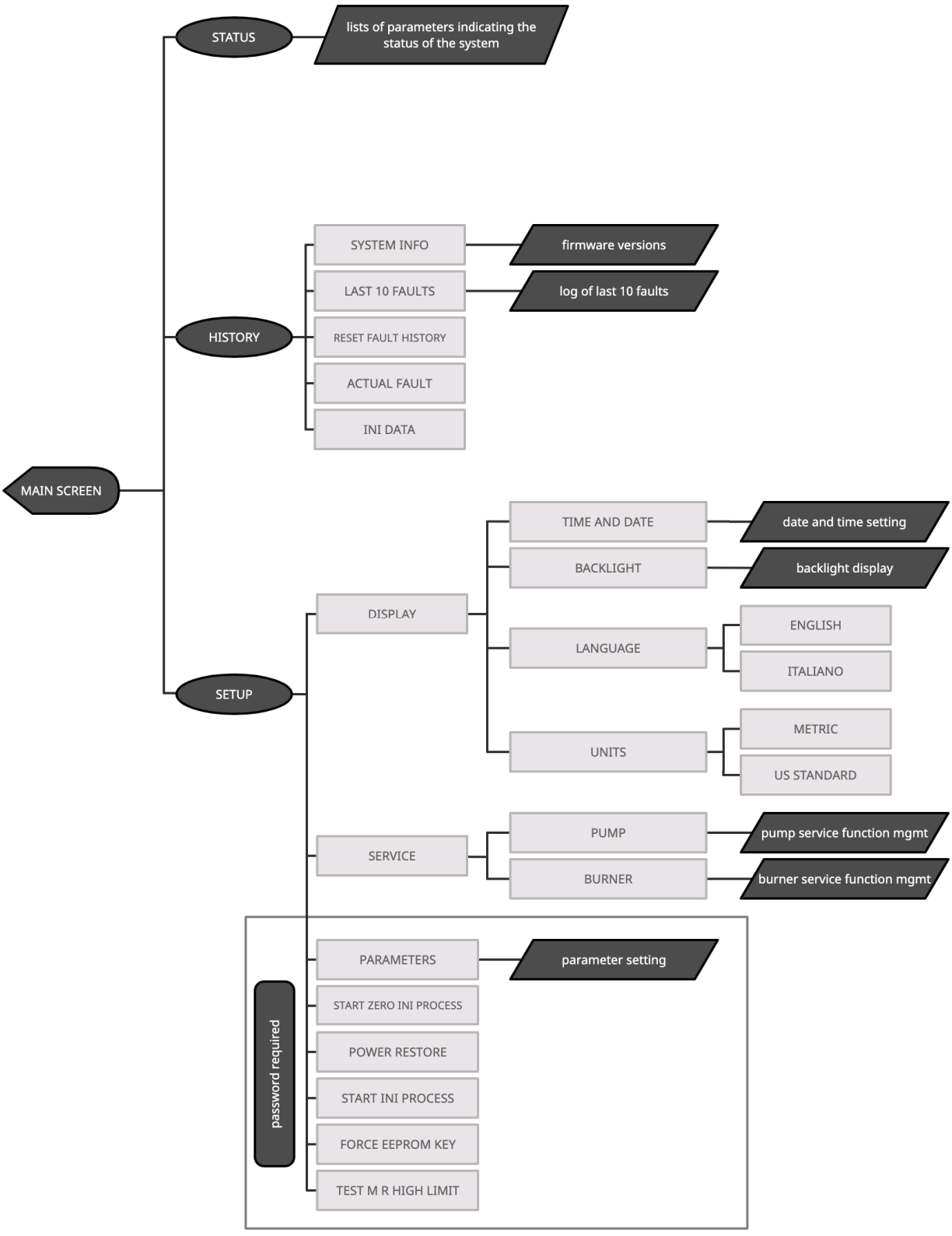
1.2 - Navigation Menus

1.2.1 - As a Standalone Appliance - HOT™ Control Menu Navigation



General Information, cont.

1.2.2 - As part of a Cascade - HOT™ Control Menu Navigation



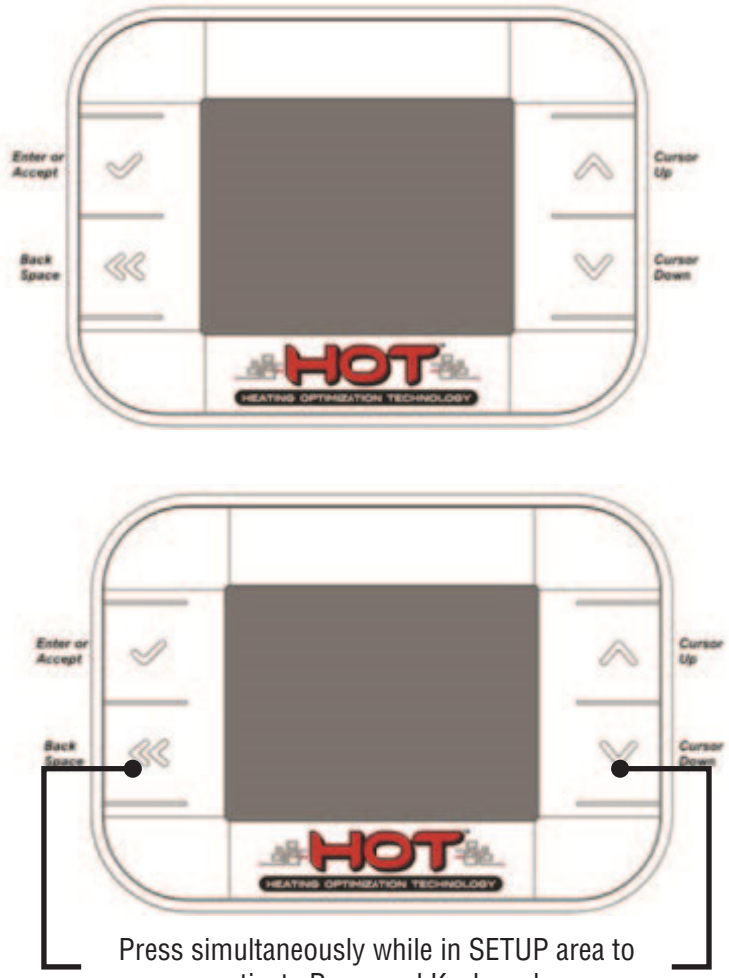
General Information, cont.

1.3 - Appliance Controls

1.3.1 - Appliance Control Components

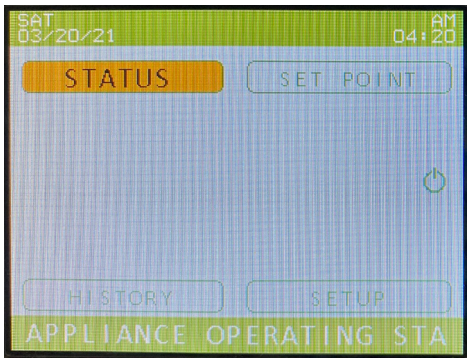
The following components are found on the control panel on the front of the appliance.

1. POWER On/Off Switch
2. Display Interface

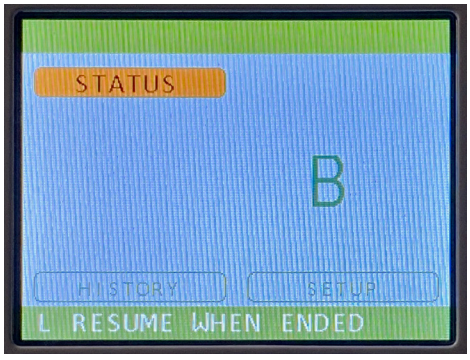


Press simultaneously while in SETUP area to activate Password Keyboard

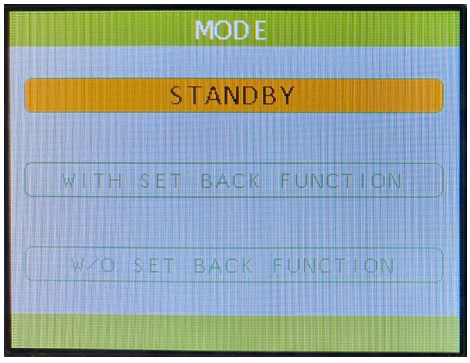
Figure 1 Appliance Control Panel



Standby Status



Normal Operating Status in Cascade



Normal Operating Status in Single Appliance

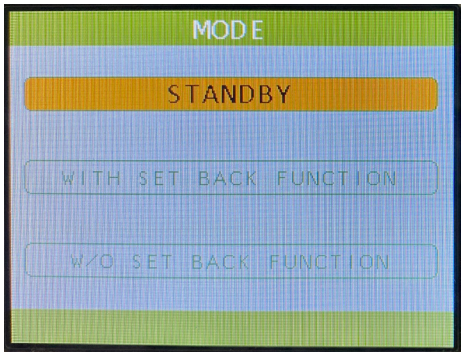
General Information, cont.

1.3.2 - Appliance Control Board (BCB Screens)

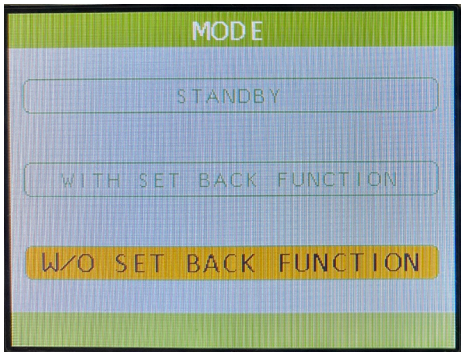
In the main screen, it is possible to see:

- Set point value
- Type of system (icons)
- Date and time
- Labels for navigation through the controller (STATUS, SET POINT, HISTORY, SETUP)
- Information and tips
- Alarms (Soft lockout yellow and hard lockout red)

Navigation and settings are allowed by using the arrow, ✓, and BACK buttons



Standby Mode

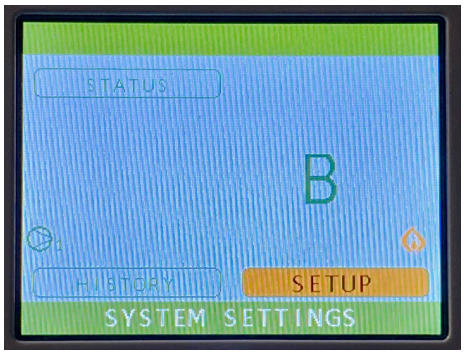


Operating Mode

Burner On (Flame Icon)

SLO Warning and Pump On Icon

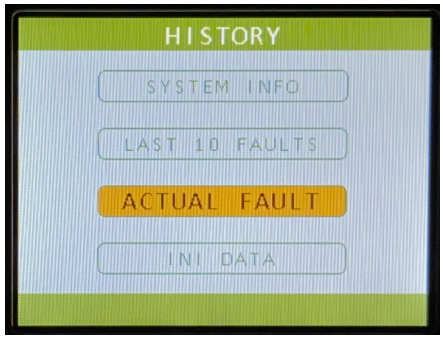
HLO Warning and Pump On Icon



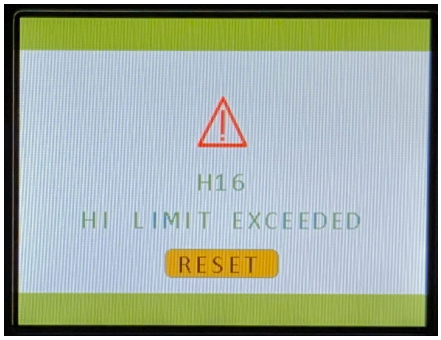
Entering SETUP Functions Area

General Information, cont.

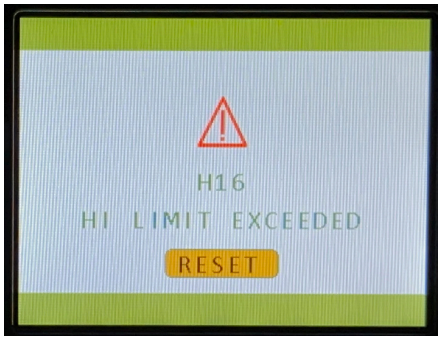
In case of fault indication (SLO or HLO), the main page shows the code of the fault occurred. To see the extended description you have to go into HISTORY menu, where a new item “ACTUAL FAULT” will be displayed. In case an appliance RESET is required (HLO fault), it is possible to activate the RESET procedure entering the ACTUAL FAULT page and selecting the corresponding item.



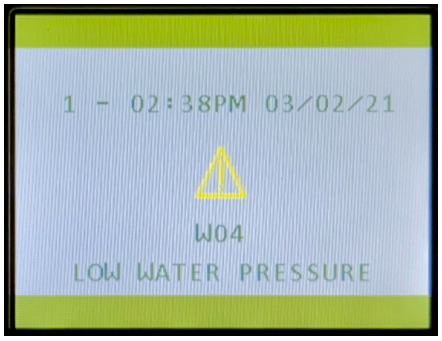
HISTORY then to view ACTUAL FAULT



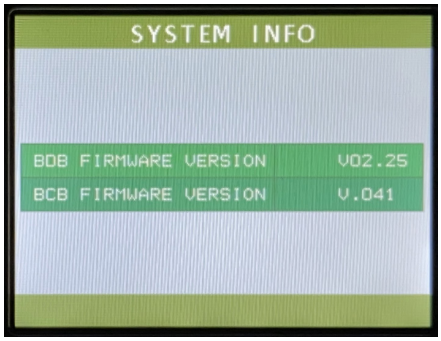
ACTUAL FAULT (HLO)



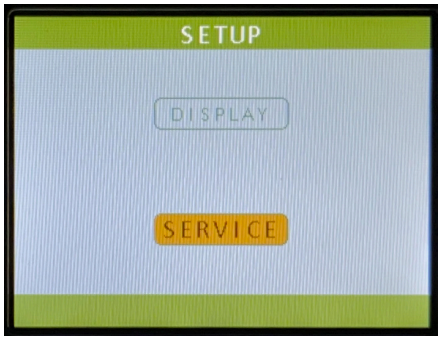
Click ✓ button to RESET fault



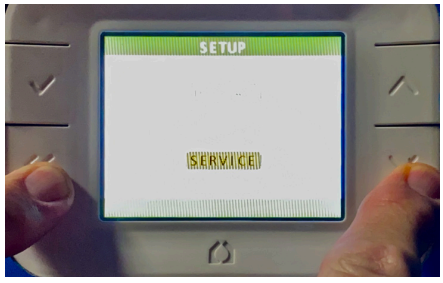
Last 10 Faults (SLO)



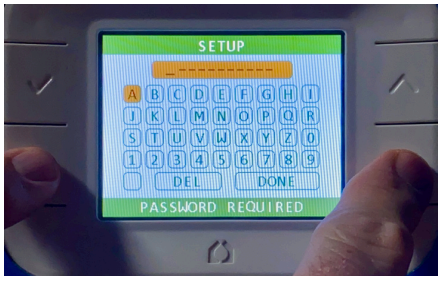
HISTORY, then SYSTEM INFO



SETUP, then enter password mode

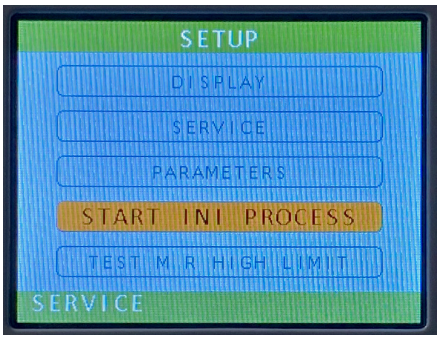


Press to enter password mode
(press and hold simultaneously as shown)

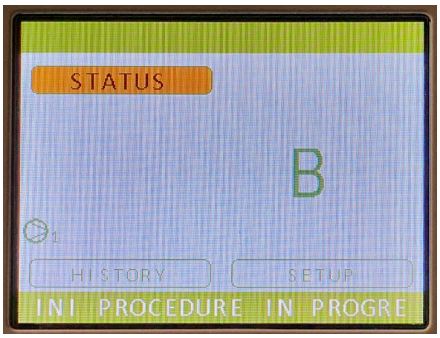


Password keyboard: navigate using the arrow keys to the letter you need, then press the ✓ button to move to the next letter.

PASSWORD entered, select DONE



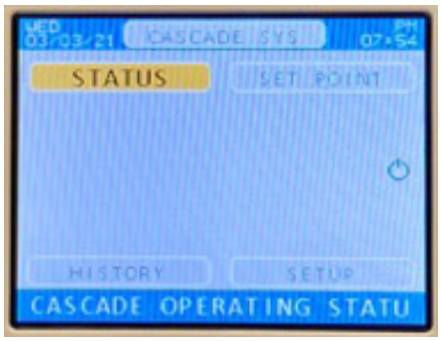
Options in Password Mode



Home screen during INI process

General Information, cont.

1.4 - Cascade Display Functions



Standby Mode

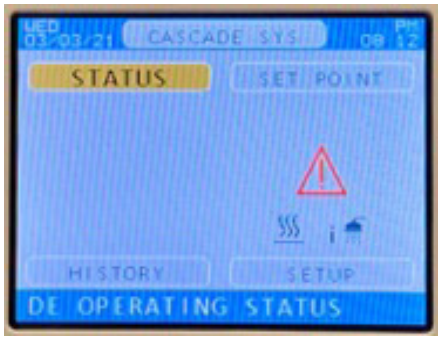
Operating Mode (No demand)

Icons indicate what mode the appliance is in

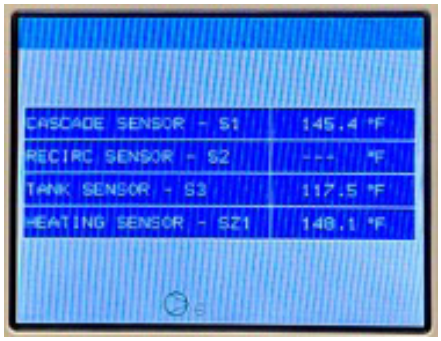
One or more appliances on

Flashing icon indicates demand in process (iDHW)

Flame icons indicate that the appliance is in a burn cycle - shows proof of flame rectification

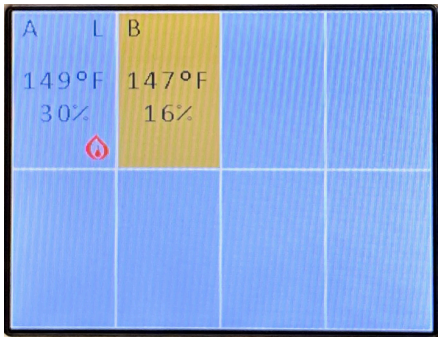


One or more appliances HLO

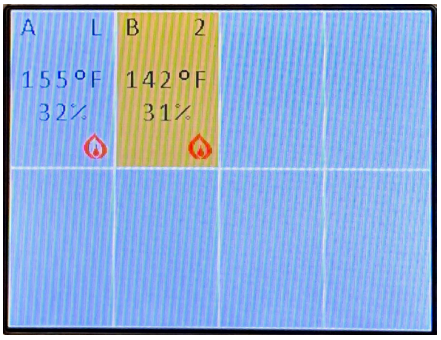


Status/Cascade
(Sensor S2 not connected)

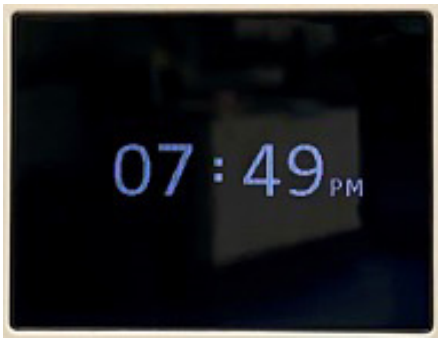
General Information, cont.



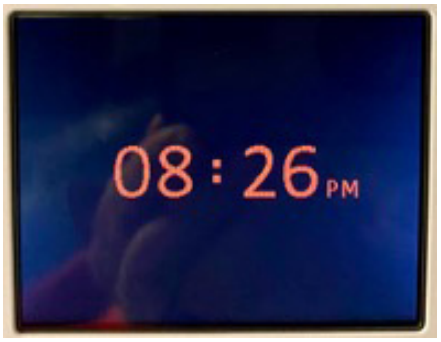
Appliance A is the lead as indicated by the L. The A appliance is also in a burn cycle illustrated by the flame icon. The fan speed is shown as a %. In common vent systems all appliances will have a minimum fan speed even if the appliance is not firing, as long is there is a call for heat.



Both appliances are in a burn cycle. A is the lead and B is 2nd in line as indicated by the 2.



Display screen saver mode



Screen saver with fault on one or more appliances

General Information, cont.

1.5 - Sensor Tables

Number	Sensor Part Name (Part Number)	Location - BCB (Boiler Control Board)
T1.1	Supply temperature - Adjustable Manual Reset High Limit TST 75001 (D104920)	BCB - Appliance outlet pipe
T1.2	Supply temperature p/n see above, duplex sensor	BCB - Appliance outlet pipe
T2	Return temperature TST 75000 (D104919)	BCB - Appliance header
T3*	Tank for iDHW and DHW temperature TST 76110 (D122338)	BCB to external component
T4*	Outdoor temperature TST 73010 (D119213)	BCB to external location
T5	Flue gas temperature TST 75002 (D104921)	BCB - Appliance flue outlet
T6*	External system water temperature TST 76110 (D122338)	BCB - Primary piping or Low Loss Header
TR1	Fan Air Pressure transducer PTR 12323 (D104963)	BCB - Fan outlet
TR2	Gas Inlet pressure transducer PTR 12304 (D104962)	BCB - Gas valve inlet

Number	Temperature Sensor Part Name	Location - CCB (Cascade Control Board)
S1	Cascade system sensor - linked to Pump 4	CCB - Primary piping or Low Loss Header
S2	DHW recirc sensor - linked to Pump 8	CCB supply or return to zone with Pump 8, if the application is iDHW or DHW, it is used as the return line sensor to control Pump 8
S3	Tank iDHW or DHW sensor - linked to Pump 5	CCB - Cascade Control Board
S4	Load/Zone sensor - linked to Pump 6	CCB supply or return to zone with Pump 6
S5	Load/Zone sensor - linked to Pump 7	CCB supply or return to zone with Pump 7
S6	Outdoor sensor	CCB to external location
S7	Load/Zone sensor - linked to Pump 9	CCB supply or return to zone with Pump 9

Note: All temperature sensors (T1.1–T2, S1–S7) are 10k thermistors, all pressure transducers (TR1–TR5) are 5vdc. Transducers are specific to their purpose; pressure range, accuracy and media being measured; gas, water or air/gas.

1.6 - Glossary

APS
Air pressure switch

BCB
Boiler Control Board

BDB
Boiler Display Board

Blocking
Limit situation is touched, boiler OFF; when the safe situation is restored, boiler On.

CCB
Cascade Control Board

CDB
Cascade Display Board

CH
Central Heating

Condensate
Water vapor generated as a product of combustion, which has a low pH.

DHL
Two independent sensors (high limit and outlet water) in a single well

iDHW
Indirect Domestic Hot Water

Diverter Valve
Motorized valve with spring return

DHW
Direct Hot Water production (instantaneous)

Hard Lock Out (HLO)
A significant error or issue with the appliance or system, such as multiple failures to light or an unsafe pressure differential. An error code at this level will trigger a shutdown of the affected appliance(s). Service or repair is required.

HLO
Hard Lock Out—Manual reset needed to restart the appliance

HMI
Human Machine Interface

Hysterese
Blocking set temperature+ offset temperature—hysterese is starting temperature for the boiler.

ICM
Interface Cascade Manager (with or without WiFi)

Indirect Tank
Sanitary hot water tank with a built in heat exchanger often used as a component in an iDHW system

INI
Baseline data initialization, runs by default every 14 days

Masterless Lead-Lag System
In a multi-appliance system this control system will work all connected appliances as one large team. This insures smooth distribution of the work load and even aging of all appliances connected within.
In addition, proprietary software manages common vented systems insuring equal back-pressure on all connected appliances and safe operation in the event of a component failure of one or more of connected appliances.

Modbus
For Ethernet or RS232 or RS485 bus system for Lead and Leg communication

Offset
Overriding temperature above set blocking: boiler OFF

PAVO
Zone controller

PCB
Printed circuit board—burner control board

Soft Lock Out (SLO)
Manual reset or appliance reset needed for restart

Tank
Domestic Hot Water Tank without internal heat exchanger

Three-Way Valve
Motorized valve: turning to the right and to the left

Parameter
P followed by a letter and number (Ex: PS18 = parameter S-18)

n.a.
Not applicable. Constant value.

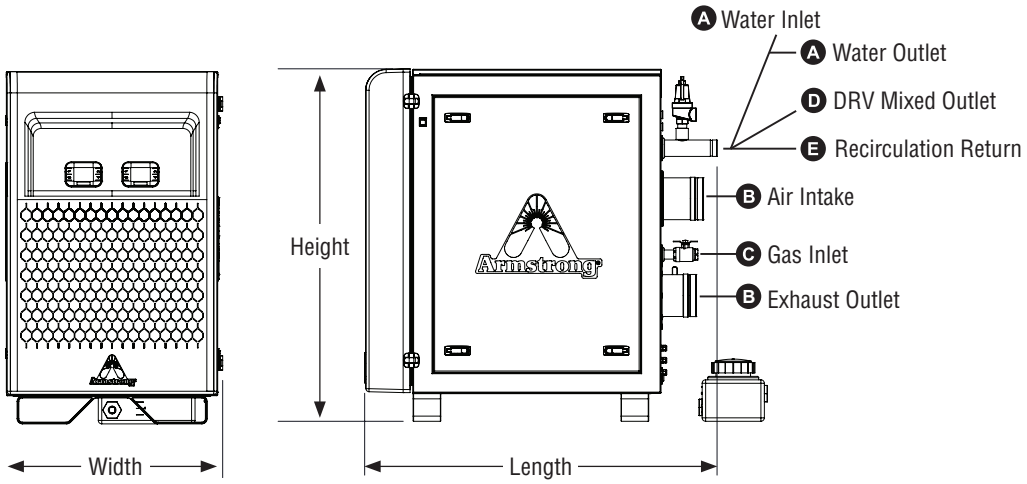
TBD
To be defined

Z-INI First INI process

General Information, cont.

1.7 - Dimensions and Performance Charts

1.7.1 - Dimension Diagram



Model	Width		Height		Depth		A (VIC Groove)		B		C		D		E	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
ASCEND 800	31.6	803.2	64.5	1638	51	1295	2	50	6	152	1.5	38	1-1/2	38	1	25
ASCEND 1000	31.6	803.2	64.5	1638	69.2	1757.4	2	50	6	152	1.5	38				
ASCEND 1500	31.6	803.2	64.5	1638	69.2	1757.4	2	50	8	203	1.5	38				

Model	Shipping Weight	
	lb	kg
ASCEND 800	650	295
ASCEND 1000	750	340
ASCEND 1500	850	385

1.7.2 - ASCEND 800 Performance Charts and Heat Exchanger Data

Delivered GPM to Delta T (F) Performance Chart							
Model ASCEND 800	Delta T (F) Based on 125°F DRV Set Point				Minimum System Draw-Off	Minimum Recirculation Flow Rate	Cv
	85	75	65	55			
GPM	18.8	21.3	24.6	29	0 GPM	2 GPM	9.8

Pressure Drop in PSIG to Flow Rate in GPM Performance Chart							
Model ASCEND 800	Pressure Drop (PSIG)				Minimum System Draw-Off	Minimum Recirculation Flow Rate	Cv
	5	10	15	20			
GPM	22	31	39	45	0 GPM	2 GPM	9.8
Model ASCEND 800	Pressure Drop (BARG)				Minimum System Draw-Off	Minimum Recirculation Flow Rate	Cv
	0.3	0.7	1.0	1.4			
LPM	81	118	145	171	0 LPM	2 LPM	8.5

Heat Exchanger Data				
Model ASCEND 800	Input		Water Heater Output	
	BTU	kW	BTU	kW
	795,000	233	up to 771,150	up to 226

General Information, cont.

1.7.3 - ASCEND 1000 Performance Charts and Heat Exchanger Data

Delivered GPM to Delta T (F) Performance Chart							
Model ASCEND 1000	Delta T (F) Based on 125°F DRV Set Point				Minimum System Draw-Off	Minimum Recirculation Flow Rate	C_V
	85	75	65	55			
GPM	23.5	26.8	30.8	36.4	0 GPM	5 GPM	22

Pressure Drop in PSIG to Flow Rate in GPM Performance Chart							
Model ASCEND 1000	Pressure Drop (PSIG)				Minimum System Draw-Off	Minimum Recirculation Flow Rate	C_V
	5	10	15	20			
GPM	48	70	85	98	0 GPM	5 GPM	22
Model ASCEND 1000	Pressure Drop (BARG)				Minimum System Draw-Off	Minimum Recirculation Flow Rate	C_V
	0.3	0.7	1.0	1.4			
LPM	181.7	265	321	371	0 LPM	19 LPM	19

Heat Exchanger Data				
Model ASCEND 1000	Input		Water Heater Output	
	BTU	kW	BTU	kW
	999,000	293	up to 969,999	up to 284

1.7.4 - ASCEND 1500 Performance Charts and Heat Exchanger Data

Delivered GPM to Delta T (F) Performance Chart							
Model ASCEND® 1500	Delta T (F) Based on 125°F DRV Set Point				Minimum System Draw-Off	Minimum Recirculation Flow Rate	C_V
	85	75	65	55			
GPM	35.3	40	46.2	54.6	0 GPM	5 GPM	22

Pressure Drop in PSIG to Flow Rate in GPM Performance Chart							
Model ASCEND 1500	Pressure Drop (PSIG)				Minimum System Draw-Off	Minimum Recirculation Flow Rate	C_V
	5	10	15	20			
GPM	48	70	85	98	0 GPM	5 GPM	22
Model ASCEND 1500	Pressure Drop (BARG)				Minimum System Draw-Off	Minimum Recirculation Flow Rate	C_V
	0.3	0.7	1.0	1.4			
LPM	181.7	265	321	371	0 LPM	19 LPM	19

Heat Exchanger Data				
Model ASCEND 1500	Input		Water Heater Output	
	BTU	kW	BTU	kW
	1,475,000	432	up to 1,430,750	up to 419

General Information, cont.

1.7.5 - Power Supplies

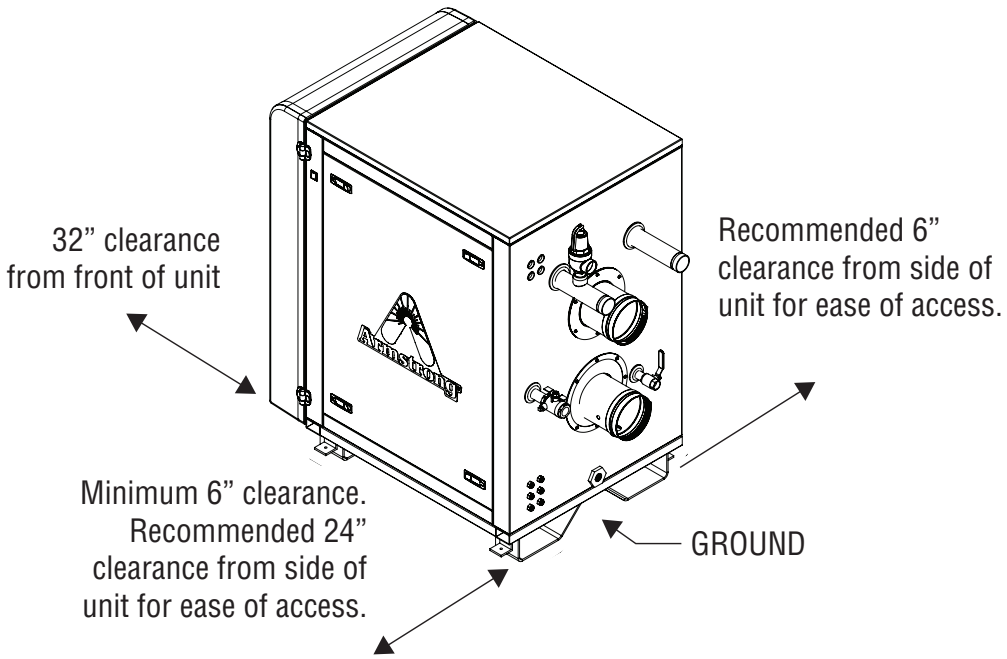
208 Volt Power Supply

Model	Amps/Unit	Heater Pump	Total Amps Boiler
HWD 800	4.44	0.96	5.40
HWD 1000	5.88	1.32	7.21
HWD 1500	9.17	2.04	11.22
Model	**Amps/Unit**	**Heater Pump**	**Total Amps Boiler**
HWD 800	4.44	0.96	5.40
HWD 1000	5.88	1.32	7.21
HWD 1500	9.17	2.04	11.22

240 Volt Power Supply

Model	Amps/Unit	Heater Pump	Total Amps Boiler
HWH 800	3.85	0.40	4.25
HWH 1000	5.1	0.48	5.58
HWH 1500	7.95	0.83	8.78
Model	**Amps/Unit**	**Heater Pump**	**Total Amps Boiler**
HWD 800	3.85	0.83	4.68
HWD 1000	5.1	1.15	6.25
HWD 1500	7.95	1.77	9.72

1.7.6 - Recommended Service Clearances



1.8 - Pre-Installation Requirements

The appliance models 800–1500 are designed to be installed using a factory designed and supplied rack or frame. It can be installed in alcoves, basements, and utility rooms, as well as standard equipment rooms. Choose a location for your appliance, centralized to the piping system, along with consideration for Electrical, Gas Connection, Venting, and Condensate Drain.

The appliance rack must be level as installed, and the mounting surface must be designed to support the weight (see previous page, Table 1-2 for weights). Be sure the appliance is adequately secured to the mounting surface.

The front cover is secured by a Hex Head Latch. When removing the front cover of the appliance, you must make sure all electric power to the appliance is turned off.

Liquid Propane

If the appliance is set up for use on liquefied petroleum (LP) gas, some geographic areas follow the Uniform Mechanical Code, section 304.6, “*Liquefied petroleum gas burning appliances shall not be installed in a pit, basement or similar location where heavier-than-air gas might collect. Appliances so fueled shall not be installed in a below grade under-floor space or basement*

General Information, cont.

unless such location is provided with an approved means for removal of unburned gas."
NOTE: A water chemistry analysis should be performed prior to any installation. If the water quality exceeds any of the following levels, then a water chemistry analysis must be performed.

- Water hardness can be no more than 12 grains (205 ppm or mg/l)
- TDS (total dissolved solids) can be no more than 450 ppm or mg/l
- pH below 6.5 or above 7.5

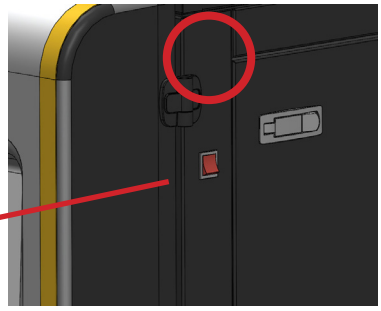
For total combined hardness over 15 grains (250 ppm or mg/l) or longer pipe lengths, contact the Manufacturer for correct pump sizing. Combined, the hardness and TDS can be no more than 450 ppm. Our internal term for this is the TCH (Total Combined Hardness).

#1 Turn off power to the unit
Turn off power at the breaker supplying power to the appliance. In a factory supplied Cascade package, turn off at the Intermediate Disconnect.

Just turning off the on-off switch on the front of the appliance does not eliminate all power from within the appliance cabinet and electrical shock hazard still exists.

NOTICE!

Condensation Removal:
This is a condensing, high efficiency appliance. Therefore condensation removal must be addressed to avoid any damage to surrounding area or the appliance. See Section 4.5 for Condensate Requirements.



#1 Turn off power to the unit at the power off switch

1.9 - Pressure Relief Valve

Do not, under ANY circumstances, thread a cap or plug into the relief valve! Explosion, severe personal injury, death, or major property damage could result.

This unit is supplied with a relief valve sized in accordance with ANSI/ASME Heater and Pressure Vessel Code, Section IV. The relief valve is installed near the hot water outlet. If the valve supplied is replaced, the pressure rating of the valve must not exceed the listed working pressure of this appliance, and must be rated to the proper BTU/hr capacity of the water heater. **Do not, under any circumstances, thread a cap or plug into the relief valve! Explosion, serious injury or death may result!**

To prevent water damage, the relief valve piping must be directed to the floor or an open drain, but not connected directly. There must be a 6" space between the outlet of relief valve piping and drain or floor. Do not hook up to drain system directly without an air gap. Protect from freezing. Place no other valve between the relief valve and the unit. Do not install any reducing couplings or other restrictions in the discharge line. The discharge line must allow complete drainage of the valve and line. Manually operate the relief valve at least once a year.

Also, care must be exercised when choosing the location of this appliance, where leakage from the relief valve, leakage from related piping, or leakage from the tank or connections, will not result in damage to the surrounding areas, or to the lower floors of the building. A water heating appliance should always be located in an area with a floor drain or installed in a drain pan suitable for water heating appliances. Under no circumstances shall the Manufacturer be held liable for any such water damage whatsoever.

2.0 - Electrical

2.1 - Electrical Connection / Requirements

The electrical connection for the appliance is on the back of the unit. There is a 1/2" knockout location for an electrical connection for the appliance's incoming power connection. All electrical wiring must be performed by a qualified licensed electrician in accordance with National Electrical Code ANSI/NFPA and/or the Canadian Electrical Code, Part 1 CSA C22.1, or to any applicable local codes and standards. For your convenience, all the points for electrical connections needed to operate the appliance are labeled.

NOTE: Always check electrical ground to known earth ground; if less than 0.5 ohms, ground is sufficient (meter MUST be on lowest setting).

We recommend a simplified test, differing from one looking for building earth ground issues, it is our intent to use this test as an indicator of equipment room electrical grounding issues, or equipment bonding issues, not prove the earth ground to the building.

Take an Ohm meter and place one lead on a known earth ground (not the ground wire on the appliance), and place the other lead on 1) The near appliance system piping, 2) The appliance heat exchanger, or 3) The appliance cabinet.

If any of those readings exceed 0.5 Ohms, then it is a good indicator that there may be sufficient stray current flowing through the water in the piping system to accelerate or amplify conditions that can cause pump, appliance or piping issues in the not too distant future.

NOTE: If any readings are over 0.5 ohms, an electrician should be brought in to correct the problem.

The electrical requirements are for standard 208–240 volt split phase, 50/60 Hz 15 Amp service. When the unit is first powered on, there is a self-setting of the electronics for 50 Hz or 60 Hz. At every power up, the electronics will take a couple of seconds to compare the pulses of the power to the pulses of the crystal, which is built into the electronics. Then all time-related functions are correct no matter the power source.

The standard supplied pumps are all 208–240 VAC, 60 cycle and are to be wired to terminals indicated on the appliance. In 50 cycle applications, other pumps may need to be supplied, depending on water conditions.

2.2 - Internal Wiring Connections

CAUTION!

The incoming power shall be connected directly to the labeled, intended connection points only. Failure to do so may result in an electrical short and the control board will have to be replaced!

DANGER!

It is extremely important that this unit be properly grounded! It is very important that the building ground is inspected by a qualified electrician prior to making this connection!

Failure to confirm proper grounding and the absence of stray voltage may result in premature component failure. See start up and commissioning documents for details.

Terminal G in the electrical compartment must be connected to the building ground system.

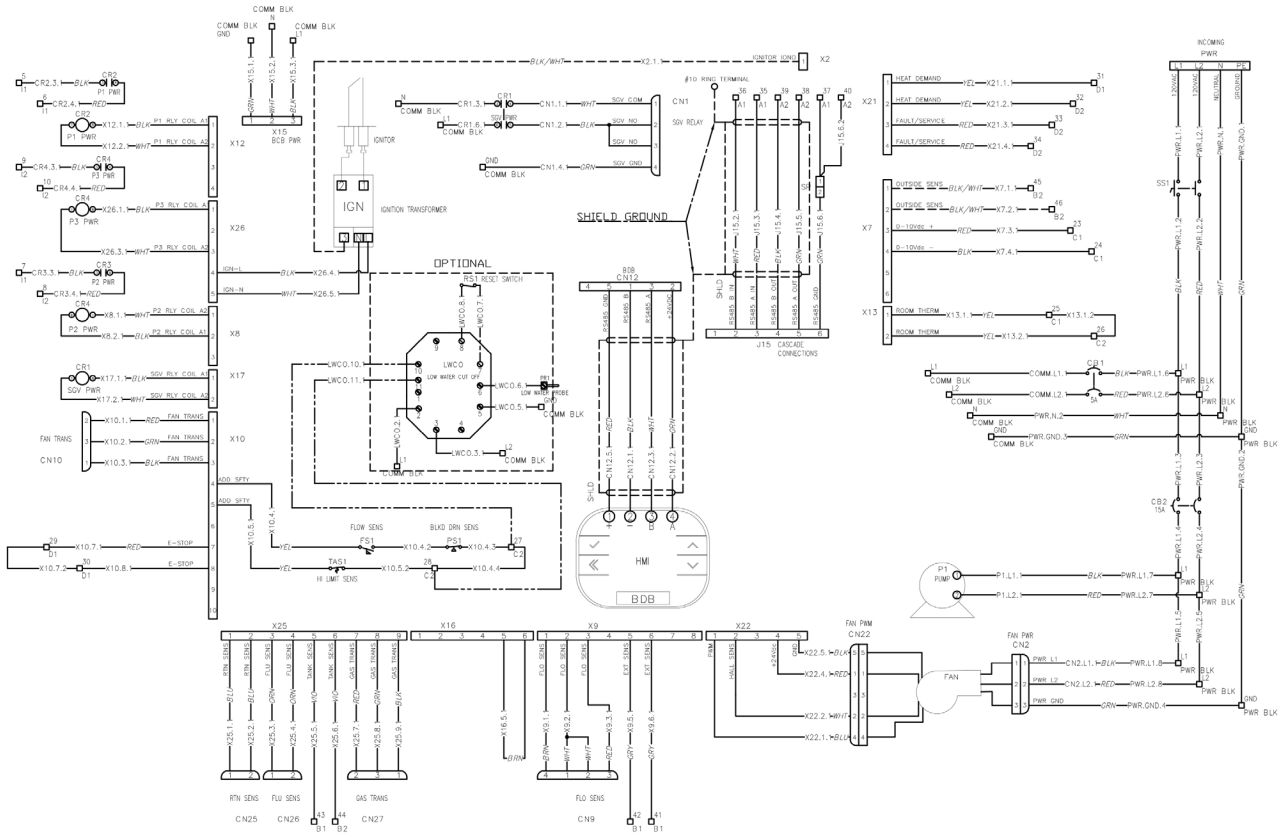
The incoming 208–240 volt split phase power supply is connected to terminals L1, L2, N and ground, see drawings.

It is important that the electrical power is not turned on at this time. Double check all connections and then turn the power on. The display that is provided with the appliance should now be reading the Setpoint temperature.

NOTE: See Section 6 (Start-Up Procedures) to change the temperature setting or run the appliance.

Electrical, cont.

ASCEND® BCB Layout



Electrical, cont.

Field Wiring Connections

A. **Terminals 1 and 2**: External Sensor Connection (T6) - System temperature sensor, senses water temp in a heating loop.

B. **Terminals 3 and 4**: Outdoor Sensor (T4) - Outdoor air sensor, set point will adjust based on outdoor air temperature (not needed if 0-10 VDC output is connected)

C. **Terminals 5 and 6**: 0–10 VDC - Connect a 0–10 VDC output here to vary set point temperature. Requires a connection to each appliance.

D. **Terminals 7 and 8**: Fault Service - Alarm bell or light may be connected here to indicate that the appliance is a hard lockout.

E. **Terminals 9 and 10**: Additional Heat Demand - Dry contacts that will close a thermostat on an extra appliance if the appliance is at 100% of capacity.

F. **Terminals 11 and 12**: Room Thermostat - Normally jumped. A room thermostat may be connected here to enable/disable the appliance.

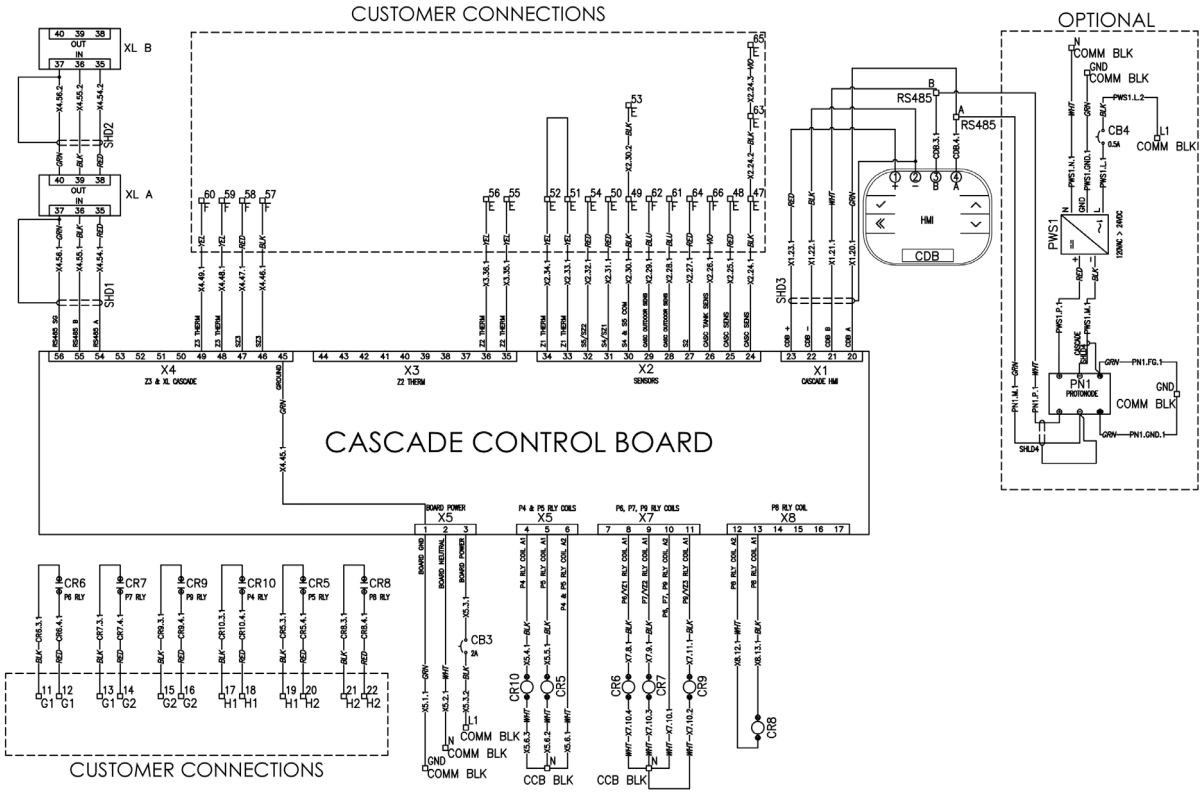
G. **Terminals 13–17**: Cascade Connection - Communication cables get connected here and “daisy chained” to all appliances in a cascade. This is polarity sensitive.

H. **Terminals 18 and 19**: Tank Sensor (T3) - Sensor for indirect or direct DHW. An aquastat may also be connected here.

I. **Terminals 20 and 21**: Additional Safety Circuit - On .3 models, it contains the Water Flow Switch; the burner door and rear wall high limits in series.

J. **Terminals 22 and 23**: E-stop - Requires a parallel wiring connection between appliances back to E-stop switch at rom wall.

Electrical, cont.



		Outputs Controlled						Switches			Sensors/input signals						
Parameter CCS1	System Description	P4 - CCB 4, 6	P5 - CCB 5, 6	P6 - CCB 8, 10	P7 - CCB 9, 10	P8 - CCB 12, 13	P9/VZ3 - CCB 10, 11	Enable / Disable CCB 33, 34	Enable / Disable CCB 35, 36	Enable / Disable CCB 48, 49	S1 - CCB 24, 25	S2 - CCB 24, 27	S3 - CCB 24, 26	S4 - CCB 30, 31	S5 - CCB 30, 32	S7/SZ3 - CCB 46, 47	S6 - CCB 28, 29
0	Heating only (CH)	x CH		x VZ1	x VZ2		x VZ3	x A1	x A2	x RZ3	x Cascade			x SZ1	x SZ2	x SZ3	x Outdoor
1	Heating with Indirect Hot Water and Recirculation		x iDHW	x VZ1	x VZ2	x Recirc	x VZ3	x A1	x A1	x RZ3	x Cascade	x Recirc	x iDHW	x SZ1	x SZ2	x SZ3	x Outdoor
2	Direct Hot Water and Recirculation					x Recirc						x Recirc	x DHW				
3	Indirect Hot Water and Recirculation		x iDHW			x Recirc		x A1	x A2	x RZ3	x Cascade	x Recirc	x iDHW				
4	iPool			x iPool				X A1 (HL)			x Cascade			x iPOOL			
5	iSPA				x iSPA				X A2 (HL)		x Cascade				x iSPA		
6	iPool and iSPA	x iPool	x iSPA	x iPool	x iSPA			X A1 (HL)	X A2 (HL)		x Cascade			x iPOOL	x iSPA		
7	One Heating zone and iPool	x iPool		x iPool			x CH	X A1 (HL)		x RZ3	x Cascade			x iPOOL		x CH	x Outdoor
8	One Heating zone and iSPA		x iSPA		x iSPA		x CH		X A2 (HL)	x RZ3	x Cascade				x iSPA	x CH	x Outdoor
9	One Heating zone and iPool and iSPA	x iPool	x iSPA	x iPool	x iSPA		x CH	X A1 (HL)	X A2 (HL)	x RZ3	x Cascade			x iPOOL	x iSPA	x CH	x Outdoor
10	iDHW and iPool and Recirculation	x iPool		x iPool		x Recirc	x iDHW	X A1 (HL)			x Cascade	x Recirc	x iDHW	x iPOOL			
11	iDHW and iSPA and Recirculation		x iSPA		x iSPA	x Recirc	x iDHW		X A2 (HL)		x Cascade	x Recirc	x iDHW		x iSPA		
12	iDHW and iPool and iSPA and Recirculation	x iPool	x iSPA	x iPool	x iSPA	x Recirc	x iDHW	X A1 (HL)	X A2 (HL)		x Cascade	x Recirc	x iDHW	x iPOOL	x iSPA		

3.0 - Gas Connections

3.1 - Gas Connection and Inspection

DANGER!

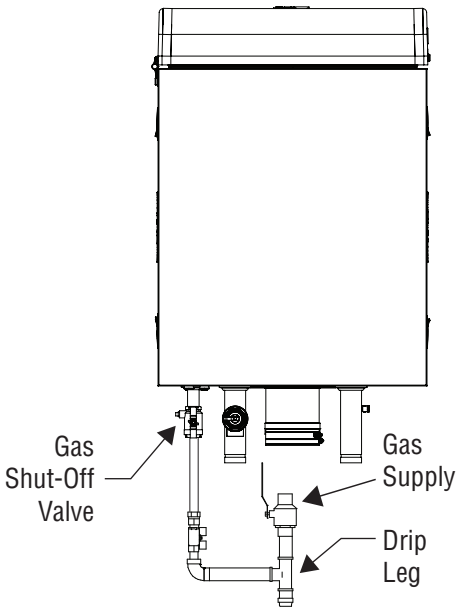
FAILURE TO FOLLOW ALL PRECAUTIONS COULD RESULT IN FIRE, EXPLOSION OR DEATH!

When attaching the gas line to the boiler hold the gas pipe on the boiler so it is not permitted to rotate while tightening the gas line.

The gas supply shall have a maximum inlet pressure of less than 14" water column (1/2 PSI) (3.44 kPa), and a minimum of 4" water column. The entire piping system, gas meter and regulator must be sized properly to prevent pressure drop greater than 1" as stated in the National Fuel Gas Code. This information is listed on the rating plate.

It is very important that you are connected to the type of gas as noted on the rating plate, "LP" for liquefied petroleum, propane gas or "Nat" for natural or city gas. All gas connections must be approved by the local gas supplier, or utility in addition to the governing authority, prior to turning the gas supply on. It is mandatory that a drip leg be fabricated, as per the National Fuel Gas code. Once all the inspections have been performed, the piping must be leak tested. It is recommended that a soapy solution be used to detect leaks. Bubbles will appear on the pipe to indicate a leak is present. If the leak test requirement is a higher test pressure than the maximum inlet pressure, you must isolate the appliance from the gas line. In order to do this, you must shut the gas off using factory and field-installed gas cocks (following the lighting instructions in Section 6.2) This will prevent high pressure from reaching the valve. Failure to do so may damage the gas valve.

NOTE: Never use an open flame (match, lighter, etc.) to check gas connections.



3.2 - Gas Piping

The gas piping must be sized for the proper flow and length of pipe, to avoid pressure drop. Both the gas meter and the gas regulator must be properly sized for the total gas load. If you experience a pressure drop greater than 1" WC, the meter, regulator or gas line is undersized or in need of service. You can attach a manometer to the 1/4" NPT port provided on the gas cock. Alternatively, you can attach the manometer to the incoming gas drip leg, by removing the cap and installing the manometer

The gas pressure must remain between 4" and 14" during stand-by (static) mode and while in operating (dynamic) mode. If an in-line regulator is used, it must be a minimum of 10 equivalent feet from the appliance. It is very important that the gas line is properly purged by the gas supplier or utility. Failure to properly purge the lines or improper line sizing, will result in ignition failure. This problem is especially noticeable in NEW LP installations and also in empty tank situations. This can also occur when a utility company shuts off service to an area to provide maintenance to their lines. This gas valve must not be replaced with a conventional gas valve under any circumstances. As an additional safety feature, this gas valve is easily de-coupled from the fan inlet.

Refer to the following tables to size the supply piping to minimize pressure drop between meter or regulator and unit.

Gas Connections, cont.

3.3 - Gas Tables

3.3.1 - Natural Gas Supply Piping

Nominal Iron Pipe	Internal Diameter	Length of Pipe (in feet)													
Size (in)	Inches	10	20	30	40	50	60	70	80	90	100	125	150	200	
3/4	0.824	363	249	200	171	152	138	127	118	111	104	93	84	72	}
1	1.049	684	470	377	323	286	259	239	222	208	197	174	158	135	} BTU/hr x 1,000
1-1/4	1.380	1,404	965	775	663	588	532	490	456	428	404	358	324	278	}
1-1/2	1.610	2,103	1,445	1,161	993	880	798	734	683	641	605	536	486	419	}
2	2.067	4,050	2,784	2,235	1,913	1,696	1,536	1,413	1,315	1,234	1,165	1,033	936	801	}

(Based on 0.60 specific gravity for natural gas at 0.5" WC pressure drop; DOE standard is 1100 BTU per cubic foot of natural gas.)

1. Run the gas supply line in accordance with all applicable codes.
2. Locate and install manual shut off valves in accordance with state and local requirements.

Nominal Iron Pipe	Outer Diameter	Length of Pipe (in meters)												
Size (DN)	mm	10	20	30	40	50	60	70	80	90	100	125	150	200	
20	26.67	110.6	75.9	60.96	52.1	46.3	42.1	38.7	35.96	33.8	31.7	28.3	25.6	21.9	
25	33.4	208.5	143.2	114.9	98.45	81.2	78.94	72.8	67.66	63.4	60.04	53.03	48.16	41.15	BTU/hr x 1,000
32	42.16	427.94	294.13	236.22	202.08	179.22	162.15	149.35	138.99	130.45	123.14	109.12	98.75	84.73	
40	48.26	640.99	440.43	353.87	302.66	268.22	243.23	223.72	208.18	195.37	184.4	163.37	148.13	127.71	
50	60.33	1234.44	848.56	681.23	583.08	516.94	468.17	430.68	400.81	376.12	355.09	314.86	285.29	244.14	

3.3.2 - Propane Supply Piping (Based on 11" WC Supply Pressure)

Nominal Iron Pipe	Internal Diameter	Length of Pipe (in feet)													
Size (in)	Inches	10	20	30	40	50	60	70	80	90	100	125	150	200	
3/4	0.824	567	393	315	267	237	217	196	185	173	162	146	132	112	}
1	1.049	1,071	732	590	504	448	409	378	346	322	307	275	352	213	} BTU/hr x 1,000
1-1/4	1.380	2,205	1,496	1,212	1,039	913	834	771	724	677	630	567	511	440	}
1-1/2	1.610	3,307	2,299	1,858	1,559	1,417	1,275	1,181	1,086	1,023	976	866	787	675	}
2	2.067	6,221	4,331	3,465	2,992	2,646	2,394	2,205	2,047	1,921	1,811	1,606	1,496	1,260	}

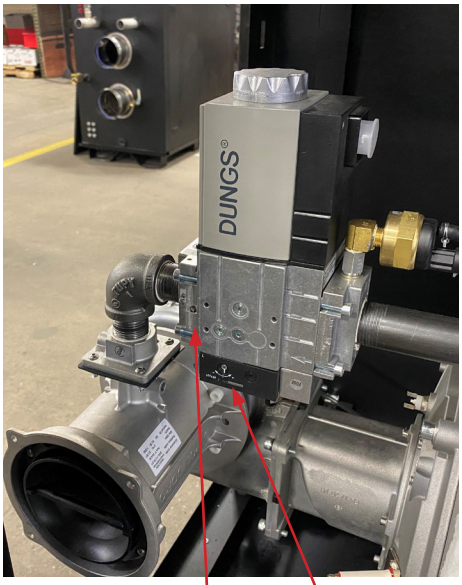
Nominal Iron Pipe	Outer Diameter	Length of Pipe (in meters)												
Size (DN)	mm	3.05	6.1	9.1	12.2	15.2	18.3	21.3	24.4	27.4	30.5	38.1	45.7	60.96	
20	26.67	172.82	119.78	96.01	81.38	72.24	66.14	59.74	56.39	52.73	49.38	44.5	40.23	34.14	
25	33.4	326.44	223.11	179.83	153.62	136.55	124.66	115.21	105.46	98.15	93.57	83.82	107.29	64.92	BTU/hr x 1,000
32	42.16	672.08	455.98	369.42	316.69	278.28	254.2	235	220.67	206.35	192.02	172.82	155.75	134.11	
40	48.26	1007.97	700.73	566.32	475.18	431.9	388.62	359.97	331.01	311.81	297.48	263.96	239.88	205.74	
50	60.33	1896.16	1320.09	1056.13	911.96	806.5	729.69	672.08	623.93	585.52	551.99	489.51	455.98	384.05	

Gas Connections, cont.

3.4 - Gas Valve Set-Up

3.4.1 - Gas Pressure Testing

NOTE: Please see Section 6.0 - Start-Up Procedures before continuing!



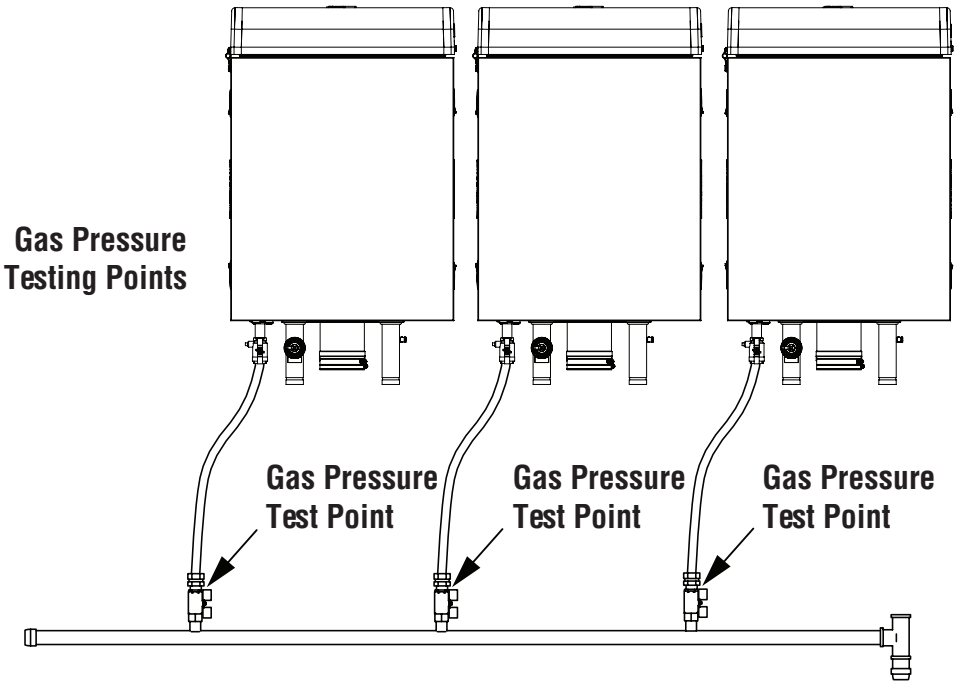
Proper gas volume and pressure is critical to the operation of any high efficiency appliance. There are three types of measurements that must be taken to provide the data to insure product performance:

1. Lock-up pressure (pressure in gas piping at appliance inlet with no load) may not exceed 14" wc. at any time!
2. Minimum load at ignition of a single unit in a multiple unit rack
3. Maximum load—all appliances on at full fire that are being tested and any other gas-fired equipment on the same gas supply.

How and where to measure:

- All gas pressure tests must be taken at the gas manifold inlet, external to the appliance (see diagram).
- Gas pressure for minimum load should be measured the moment after the gas valve opens on a single appliance, and recorded.
- Gas pressure for maximum load shall be measured with all units on at full fire and all other connected loads on that gas supply running
- Gas pressure drop shall not exceed 1" wc. between minimum load and maximum load as described above.

NOTE: Inlet gas pressure at the gas valve, may also be read on the BDB (Display screen) under the STATUS screen during all operations.



Gas Connections, cont.

NOTE: Please see Section 6.0 - Start-Up Procedures before continuing!

3.4.2 - Combustion and Fuel Related Adjustment Table

	Natural Gas CO_2			LP Gas CO_2		
	Door Closed	**Door Open**	**Approximate, do not use for setup!**	**Door Closed**	**Door Open**	**Approximate, do not use for setup!**
Low Fire	8.30%		Less than 10	9.60%		Less than 10
High Fire	8.80%		Less than 100	10.20%		Less than 120

NOTE: All adjustments must be made with the appliance door off, which will lower the CO_2 reading 0.2%. See tables above for specific readings.

When checking or replacing a gas valve, the CO_2 percentage in the flue gas is the preferred measuring method to insure proper combustion and firing rate. CO is used as the (temporary) alternate.

Changing incoming air temperature may vary the CO_2 setting slightly (~0.2–0.6%) after initial set up. This is not cause for concern or reason to set up again. After one year of operation, set up is required again.

If your appliance will be operated in an area that has inlet air temperature variations greater than 80°F, please use the following table in adjusting your CO_2 for optimum performance.

3.4.3 - CO_2 Adjustment Table

Inlet Air △T Variation	Setup at Minimum Incoming Air Temperature	Setup at Maximum Incoming Air Temperature
80°F (26.67°C)	Reduce CO_2 0.2%	Increase CO_2 0.2%
100°F (37.78°C)	Reduce CO_2 0.3%	Increase CO_2 0.3%
120°F (48.89°C)	Reduce CO_2 0.4%	Increase CO_2 0.4%

3.5 - Setting the Maximum Load

A means of sampling the leaving flue gas is built into the vent connector on top of the appliance. Remove the rubber plug for testing and replace when testing is completed. This plug MUST be in place during normal operation.

Enter the service function (reference the Control Section for instructions) from the setup menu. After the service function is active, fan speed percentage can be set. This should be set to 100% to achieve maximum fan speed for high fire combustion setting.

If necessary, turn the adjusting slot [1], which sets the high fire performance, according to the markings on the gas valve, to increase or decrease the CO_2 percentage, as shown in **Section 3.4**). Appropriate CO_2 percentages are shown in Table 3.4.3 above.

NOTE: If the system is a common vented cascade, there are specific instructions related to proper combustion setting (see Section 6.2 for details).

Gas Connections, cont.

3.5.1 - Fan Speed Requirements

HW800		
Fan Type	**Maximum RPM**	**Minimum RPM**
Ametek 8.9 High Output Enhanced +	8300	2739

HW1000		
Fan Type	**Maximum RPM**	**Minimum RPM**
Ametek 8.9 High Output Enhanced +	8800	2728

HW1500		
Fan Type	**Maximum RPM**	**Minimum RPM**
Ametek 8.9 High Output Enhanced +	10400	2496

3.6 - Setting the Minimum Load

Set the minimum load once the maximum load has been set, set the fan speed in the service function to the minimum RPM setting. In order to set or adjust the minimum load, turn the screw (2) for the minimum setting. Turn the screw according to the markings on the gas valve, to increase or decrease the CO_2 percentage.

- If the measuring process takes more than 40 minutes, the appliance will return to the automatic mode. If so required, enter the Service function another time.
- When you are done setting the valve, press stop in the Service function to return to normal run mode.

3.7 - Gas Conversion

If the appliance is to be converted in the field for using Propane (LPG), the following steps must be taken:

- Turn screw [1] clockwise (**Section 3.4**) ¾ of one turn (270°) on models 299 and 1 full turn (360°) on model HW399
- On model HW599 turn screw on left hand valve closed (clockwise) and turn right valve 1-¾ of a full turn clockwise.
- Run the appliance. If the burner does not ignite after four starting efforts, turn the screw [1] one half turn back (180°) (counter clockwise).
- After conversion, follow the steps in Sections E and F for setting the maximum and minimum loads, using the LP gas values shown in **Section 3.4.2**.

4.0 - Venting

4.1 - Approved Venting Materials

ALL VENT PIPE MATERIALS AND FITTINGS MUST COMPLY WITH THE FOLLOWING:			
Item	**Material**	**Standards for installation in:**	
		United States	**Canada**
Vent pipe and fittings	AL 29-4C Stainless	ANSI/ASTM UL1738	UL1738
	PVC schedule 40*	ANSI/ASTM D1785	CPVC and PVC venting must be ULC-S636 Certified. IPEX is an approved vent manufacturer in Canada supplying vent material listed to ULC-S636.
	CPVC schedule 40	ANSI/ASTM F441	
	Polypropylene (PP)	ULC-S636	ULC-S636
Pipe cement & primer	PVC	ANSI/ASTM D2564	IPEX System 636 Cements & Primers
	CPVC	ANSI/ASTM F493	
NOTICE: DO NOT USE CELLULAR (FOAM) CORE PIPE			

NOTE: Venting system may contain one or more of the above materials.

The appliance is a direct vent appliance and is listed as a Category IV condensing appliance. (The appliance Venting is rated at Zero Clearance to combustibles.)

SPECIAL VENTING SYSTEM DESIGN NOTES!

THE APPLIANCE EFFICIENCY TESTING AND RATINGS ARE BASED ON A SEALED, TWO PIPE VENT SYSTEM; HOWEVER, MANY OTHER VENT CONFIGURATIONS ARE AVAILABLE AS FACTORY ENGINEERED SOLUTIONS. PLEASE CONTACT THE FACTORY IF EXCEPTIONS ARE REQUIRED FOR YOUR INSTALLATION.

DANGER!

It is extremely important to follow these venting instructions carefully. Failure to do so can cause severe personal injury, death or substantial property damage.

DANGER!

This vent system will operate with a positive pressure in the vent pipe. Do not connect vent connectors serving appliances by natural draft into any portion of mechanical draft systems operating under pressure.

NOTE: If set points exceed 140°F (60°C), use of PVC is NOT recommended, even though product is approved as such. Contact the Manufacturer for further clarification.

Venting, cont.

4.2 - Venting the Appliance

Model	Vent Diameter	Standard Vent Type	Optional Vent Type	Minimum Combined Vent Length	Maximum Combined Length
HW 800	6" (152mm)	Stainless	Plastic	6' (1.8M) + (2) 90˚ elbows	240' (73.2M)
HW 1000	6" (152mm)	Stainless	Plastic	6' (1.8M) + (2) 90˚ elbows	180' (54.9M)
HW 1500	8" (203mm)	Stainless	Plastic	6' (1.8M) + (2) 90˚ elbows	400' (121.9M)

NOTE: *The use of 6" PVC will require the purchase of a special adapter from the Manufacturer.

Fittings or Piping	Equivalent Feet/M
90 degree elbow	5' (1.5M)
45 degree elbow	3' (0.9M)
Coupling	0 (0M)
Air inlet elbow	6' (1.8M)
Exhaust coupling	1' (0.3M)

The inlet and exhaust pipes on the back of the cabinet should be the diameter and material indicated in the Venting Specifications Table above. It is very important that you plan the location properly to eliminate long pipe runs and excessive fittings. Inlet pipe size must not be reduced. Do not combine the inlet air or exhaust with any other inlet or exhaust pipe including either to an additional similar appliance, unless you have purchased an engineered Common Venting System from the Manufacturer. The joints must be properly cleaned, primed and cemented if plastic, and sealed per the manufacturer's instructions if stainless. The piping must also be properly supported as per Local and National Standard Plumbing Codes. It is important that the piping must be clean and free from burrs, debris, ragged ends and particles of PVC (if applicable).

NOTE: Cascaded system may be supplied with a factory designed and assembled common vented exhaust and intake air system, those maximum lengths are determined by factory engineers on a per project basis.

Use of common venting systems not supplied by the appliance manufacturer will void certifications and warranty.

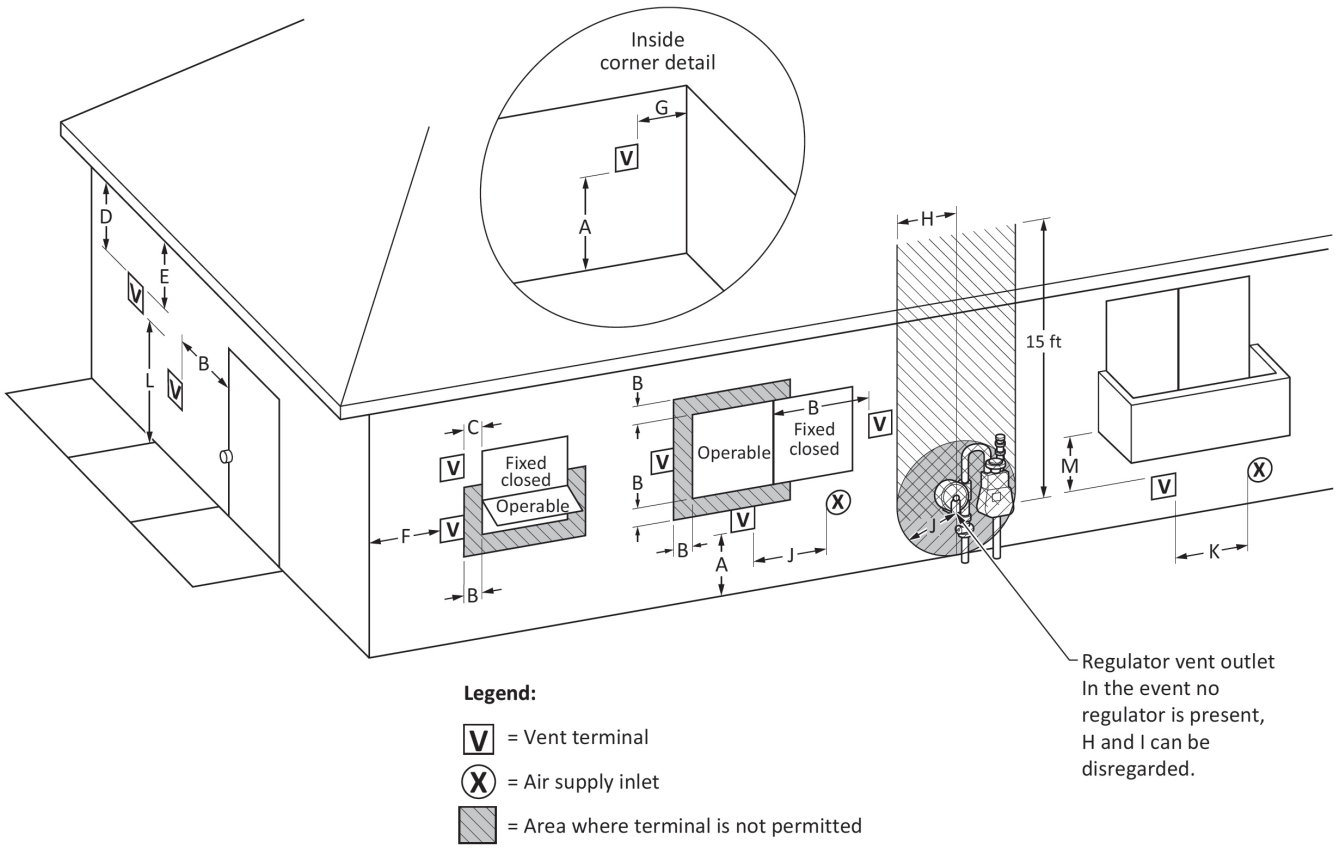
Venting, cont.

Exhaust piping should be sloped back to the connection on the appliance, at least 1/4” per foot (PP piping above 5" diameter requires 5/8" per foot) to remove additional condensate that forms within the pipe. The total combined length of pipe (intake piping plus exhaust piping added together) including elbow allowances intake and exhaust should not exceed the length shown in the vent table. The minimum combined vent length should not be less than a combined length of 6’ plus two 90° elbows. Choose your vent termination locations carefully. You must also make certain that exhaust gas does not re-circulate back into the intake pipe. You must place them in an open area and follow the following guidelines:

DANGER!

The following are code restrictions for the location of the flue gas vent terminal. Compliance to these requirements doesn’t insure a satisfactory installation; good common sense must also be applied. It is important to make sure that exhaust gases are not recirculated into the inlet air of the appliance. If there is any doubt, contact the factory BEFORE installing.

Venting, cont.



Direct Vent Terminal Clearances

		Canadian Installations	U.S. Installations
A	Clearance above grade, veranda, porch, deck, or balcony	12 in (30 cm)	12 in (30 cm)
B	Clearance to window or door that may be opened	**For appliances…** • less than 10,000 BTUh (3 kW): 6 in (15 cm) • between 10,000 BTUh (3 kW) and 100,000 BTUh (30 kW): 12 in (30 cm) • greater than 100,000 (30 kW): 36 in (91 cm)	**For appliances…** • less than 10,000 BTUh (3 kW): 6 in (15 cm) • between 10,000 BTUh (3kW) and 50,000 BTUh (15 kW): 9 in (23 cm) • greater than 50,000 BTUh (15 kW): 12 in (30 cm)
C	Clearance to a permanently closed window	**Per local installation codes**	
D	Vertical clearance to ventilated soffit located above the terminal within a horizontal distance of 2 ft (61 cm) from the center line of the terminal		
E	Clearance to unventilated soffit		
F	Clearance to outside corner		
G	Clearance to inside corner		
H	Clearance to each side of center line extended above meter / regulator assembly	3 ft (91 cm) within a height of 15 ft (4.6 m)	
I	Clearance to service regulator vent outlet	3 ft (91 cm)	
J	Clearance to non mechanical air supply inlet to building or the combustion air inlet to any other appliance	**For appliances…** • less than 10,000 BTUh (3 kW): 6 in (15 cm) • between 10,000 BTUh (3 kW) and 100,000 BTUh (30 kW): 12 in (30 cm) • greater than 100,000 (30 kW): 36 in (91 cm)	**For appliances…** • less than 10,000 BTUh (3 kW): 6 in (15 cm) • between 10,000 BTUh (3kW) and 50,000 BTUh (15 kW): 9 in (23 cm) • greater than 50,000 BTUh (15 kW): 12 in (30 cm)

Venting, cont.

Direct Vent Terminal Clearances, cont.

K	Clearance to a mechanical air supply inlet	6 ft (1.83 m)	3 ft (91 cm) above if within 10 ft (3 m) horizontally
L	Clearance above paved sidewalk or paved driveway located on public property	7 ft (2.13 m)*	Vents for Category II and IV appliances cannot be located above public walkways or other areas where condensate or vapor can cause a nuisance or hazard
M	Clearance under veranda, porch, deck, or balcony	12 in (30 cm)†	Per local installation codes

* A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings.

† Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor

NOTES:

1. In accordance with the current CSA B149.1, Natural Gas and Propane Installation Code
2. In accordance with the current ANSI Z223.1 / NFPA 54, National Fuel Gas Code
3. If locally adopted installation codes specify clearances different than those illustrated, then the most stringent clearances must prevail

Other Than Direct Vent Terminal Clearances

<table>
<tr><th colspan="2"></th><th>Canadian Installations</th><th>U.S. Installations</th></tr>
<tr><td>A</td><td>Clearance above grade, veranda, porch, deck, or balcony</td><td>12 in (30 cm)</td><td>12 in (30 cm)</td></tr>
<tr><td>B</td><td>Clearance to window or door that may be opened</td><td>For appliances…
• less than 10,000 BTUh (3 kW): 6 in (15 cm)
• between 10,000 BTUh (3 kW) and 100,000 BTUh (30 kW): 12 in (30 cm)
• greater than 100,000 (30 kW): 36 in (91 cm)</td><td>4 ft (1.2 m) below or to side of opening;
1 ft (300 mm) above opening</td></tr>
<tr><td>C</td><td>Clearance to a permanently closed window</td><td colspan="2" rowspan="5">Per local installation codes</td></tr>
<tr><td>D</td><td>Vertical clearance to ventilated soffit located above the terminal within a horizontal distance of 2 ft (61 cm) from the center line of the terminal</td></tr>
<tr><td>E</td><td>Clearance to unventilated soffit</td></tr>
<tr><td>F</td><td>Clearance to outside corner</td></tr>
<tr><td>G</td><td>Clearance to inside corner</td></tr>
<tr><td>H</td><td>Clearance to each side of center line extended above meter / regulator assembly</td><td>3 ft (91 cm) within a height of 15 ft (4.6 m)</td><td rowspan="2"></td></tr>
<tr><td>I</td><td>Clearance to service regulator vent outlet</td><td>3 ft (91 cm)</td></tr>
<tr><td>J</td><td>Clearance to non mechanical air supply inlet to building or the combustion air inlet to any other appliance</td><td>For appliances…
• less than 10,000 BTUh (3 kW): 6 in (15 cm)
• between 10,000 BTUh (3 kW) and 100,000 BTUh (30 kW): 12 in (30 cm)
• greater than 100,000 (30 kW): 36 in (91 cm)</td><td>4 ft (1.2 m) below or to side of opening;
1 ft (300 mm) above opening</td></tr>
<tr><td>K</td><td>Clearance to a mechanical air supply inlet</td><td>6 ft (1.83 m)</td><td>3 ft (91 cm) above if within 10 ft (3 m) horizontally</td></tr>
<tr><td>L</td><td>Clearance above paved sidewalk or paved driveway located on public property</td><td>7 ft (2.13 m)*</td><td>Vents for Category II and IV appliances cannot be located above public walkways or other areas where condensate or vapor can cause a nuisance or hazard</td></tr>
<tr><td>M</td><td>Clearance under veranda, porch, deck, or balcony</td><td>12 in (30 cm)†</td><td>Per local installation codes</td></tr>
</table>

* A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings.

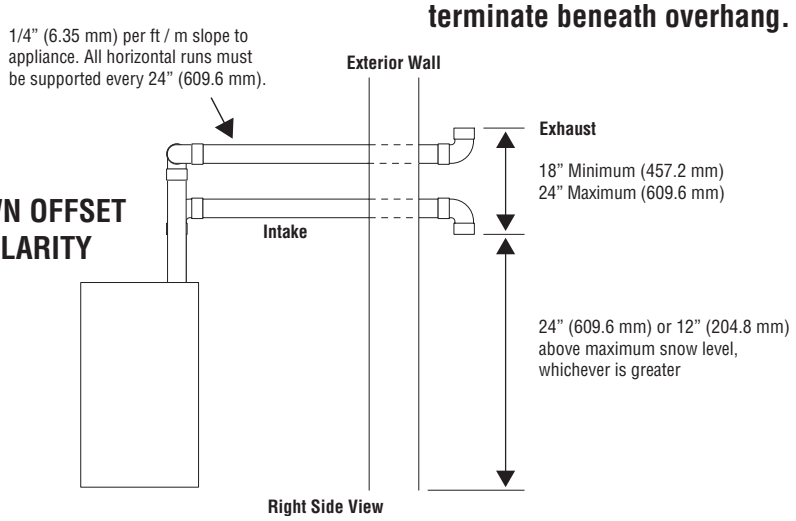
† Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor

NOTES:

1. In accordance with the current CSA B149.1, Natural Gas and Propane Installation Code
2. In accordance with the current ANSI Z223.1 / NFPA 54, National Fuel Gas Code
3. If locally adopted installation codes specify clearances different than those illustrated, then the most stringent clearances must prevail

Venting, cont.

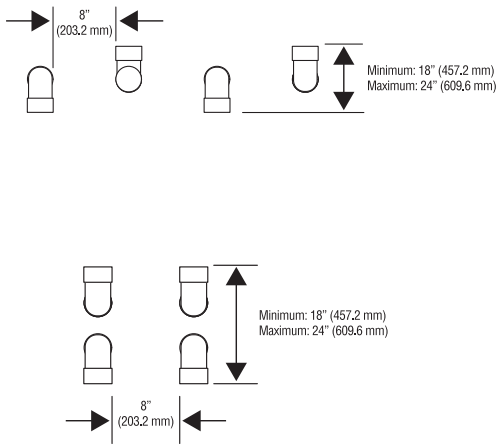
PLEASE NOTE: Exhaust must not terminate beneath overhang.

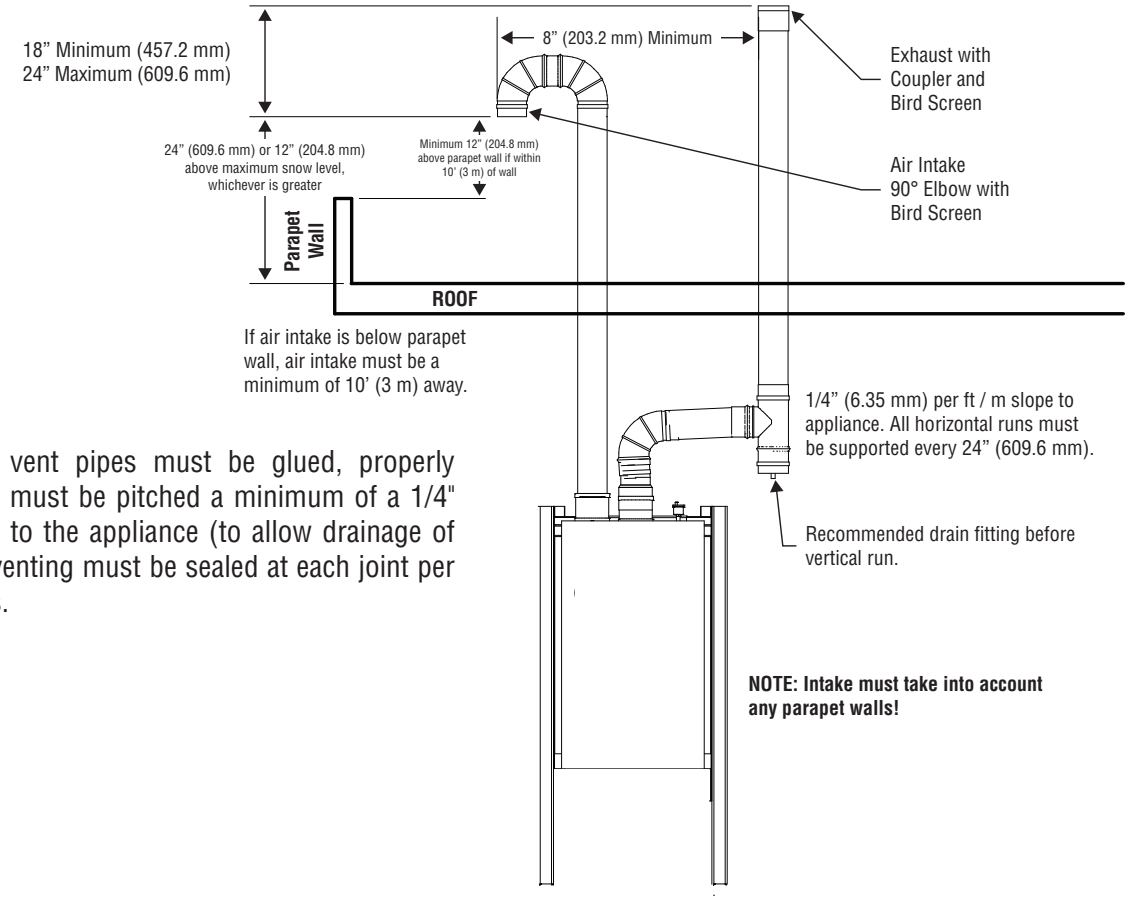


****IMPORTANT NOTE:** All vent pipes must be glued, properly supported and the exhaust must be pitched a minimum of a 1/4" (6.35mm) per foot/M back to the appliance (to allow drainage of condensate). All stainless venting must be sealed at each joint per manufacturer's instructions.

VENTING FOR MULTIPLE UNITS

With vents on all same horizontal plane, spaced at least 8" (203.2 mm) apart, and at the level of highest unit

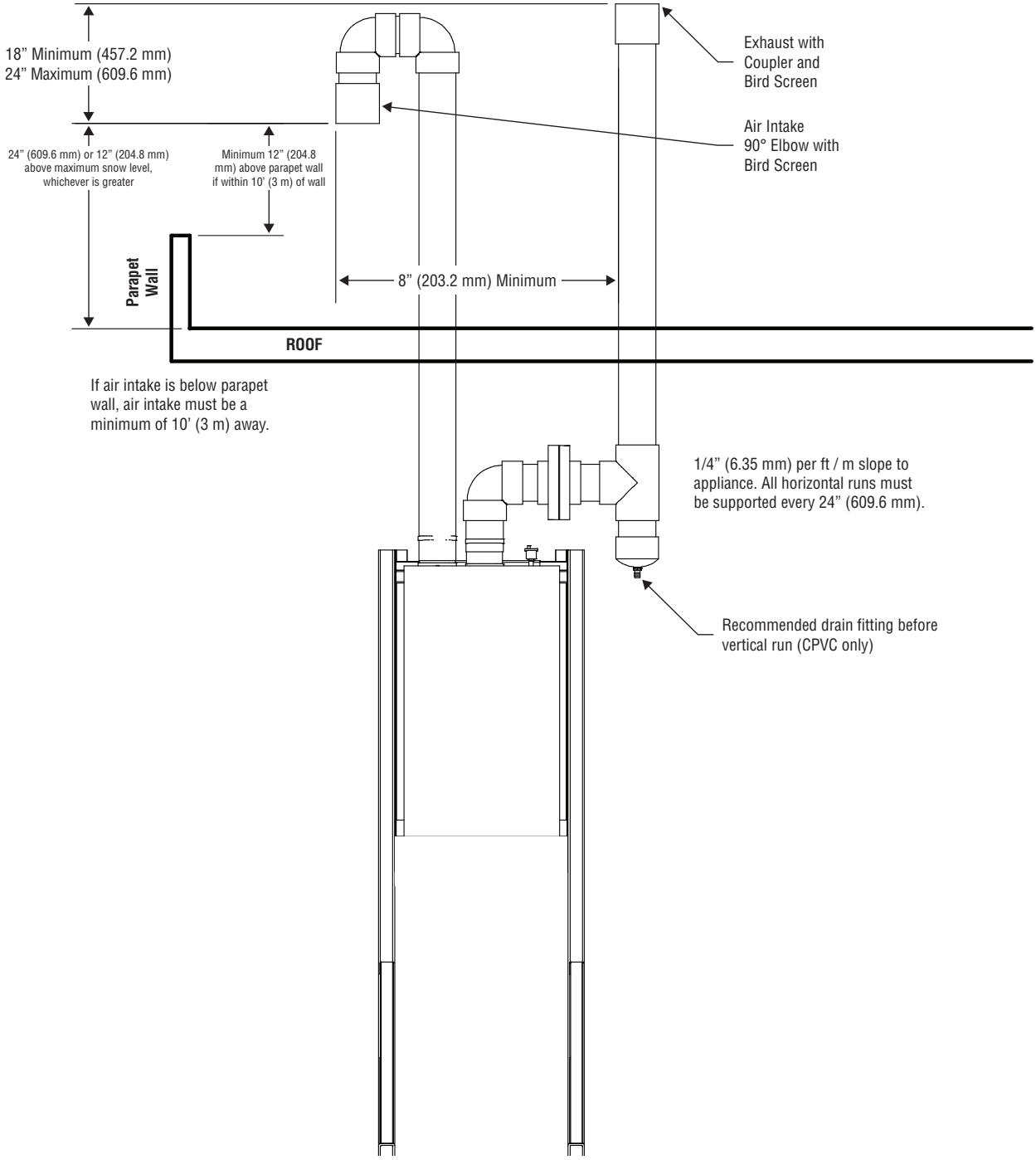




****IMPORTANT NOTE:** All vent pipes must be glued, properly supported and the exhaust must be pitched a minimum of a 1/4" (6.35mm) per foot/M back to the appliance (to allow drainage of condensate). All stainless venting must be sealed at each joint per manufacturer's instructions.

Venting, cont.

Vertical Vent with PVC/CPVC



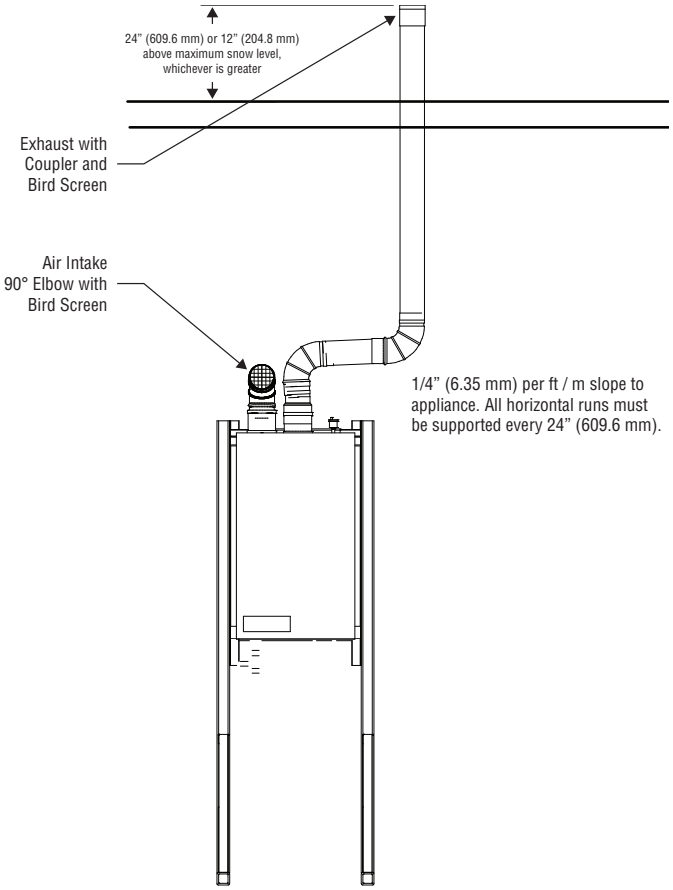
Venting, cont.

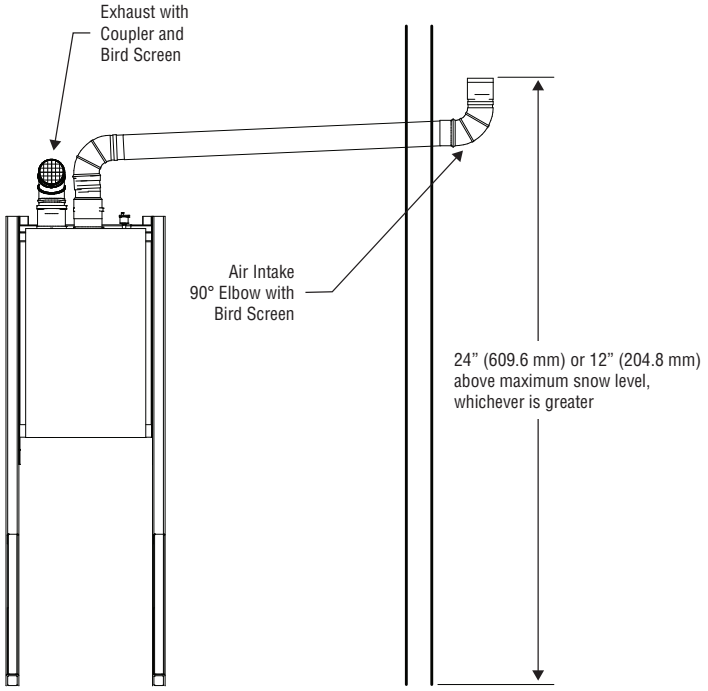
Diagrams for Room Air Venting Termination

When using room air, the unit should be set up as follows.

CAUTION!

Flue Gas will condense as it exits the vent termination. This condensate can freeze on exterior building surfaces which may cause discoloration of these surfaces. Consideration should be given to the plume of condensation that exits the exhaust which may affect the cosmetic appearance of the building.





As long as the boiler room remains under a positive pressure under all operating conditions of the building, this is a perfectly acceptable option. Generally, all this requires is an external free air source; typically just two properly sized openings to the outdoors. Installations done in this manner must comply with ANSI Z223.1, NFPA 54—National Fuel Gas Code 2009 section 9.3, and any specific local codes that may require additional combustion air be provided. For the latest edition, see Technical Bulletin–TB 003. This would be our preferred alternate to our standard manual specifications.

NOTE: Stated efficiencies are based on ducted air; using room air may effect efficiency.

Venting, cont.

4.3 - Inlet Air Vent

You may use the same material as used for exhaust or any material that is the same diameter that provides a pressure tight connection. **THIS IS ONLY FOR INLET AIR, NOT FOR EXHAUST PIPING!**

The air inlet must be a minimum of 12" (204.8mm) vertically above the maximum snow level. It is very important that there are no other vents, chimneys or air inlets in any direction for at least 48" (1219.2mm).

All venting must be properly supported. The appliance is not intended to support any venting whatsoever. All piping, glue, solvents, cleaners, fittings and components, must conform to ASTM (American Society for Testing and Materials), and ANSI (American National Standards Institute).

4.4 - Venting Runs that Exceed Maximum Combined Length

If the combined venting length of an appliance's exhaust/inlet air system exceeds the Maximum Combined Length called out in **Section 4.2**, contact the manufacturer for an engineered venting calculation. Do not proceed without calling the Manufacturer.

VENT CALCULATION EXAMPLE: Installation requires the following material for both inlet and exhaust piping for the 800 (maximum combined equivalent length is 180 feet).

Required: 8 Pcs. 90° elbow (8 x 5 = 40 equivalent feet)	=	40 equivalent feet
Required: 60' of stainless steel pipe (60 x 1 = 60 equivalent feet)	=	60 equivalent feet
Required: Inlet air vertical termination (2) 90° elbows + bird screen)	=	11 equivalent feet
Required: Exhaust bird screen	=	1 equivalent foot
Total friction loss in equivalent feet	=	**112 equivalent feet**

DANGER!

The appliance is not intended to be common vented with any other existing appliance! Multiple appliance products may be common vented, only if using an engineered system by the Manufacturer.

Venting, cont.

4.5 - Condensate Requirements

This is a condensing high efficiency appliance, therefore this unit has a condensate removal system. Condensate is nothing more than water vapor derived from the combustion products, similar to an automobile when it is initially started. This condensate does have a low pH and should be treated with a Condensate Neutralizer Filter. This filter contains either lime or marble rocks, which will neutralize the condensate. The outlet of the filter is sized for 3/4" hose. **It is very important that the condensate line is sloped away from and down to a suitable inside drain.** A condensate neutralizer and a condensate pump kit are available from the Manufacturer. It is also very important that the condensate line is not exposed to freezing temperatures, or any other type of blockage. Plastic tubing or PVC pipe should be the only materials used for the condensate line. Steel, brass, copper or others will be subject to corrosion and deterioration. A second vent may be necessary to prevent condensate line vacuum lock if a long horizontal run is used. The appliance has an automatic safety device that will shut it down in the event of a condensate drain blockage. Please test annually.

Maximum volume of condensate produced is 11 gallons per hour (41.6LPM) per 1,000,000 BTU of gas burned.

WARNING!

In a common vent system, **DO NOT POWER THE UNIT OFF!** Equipment damage may occur. To disable operation, turn off gas, NOT power. If you have any questions, please call Technical Support.

5.0 - Piping

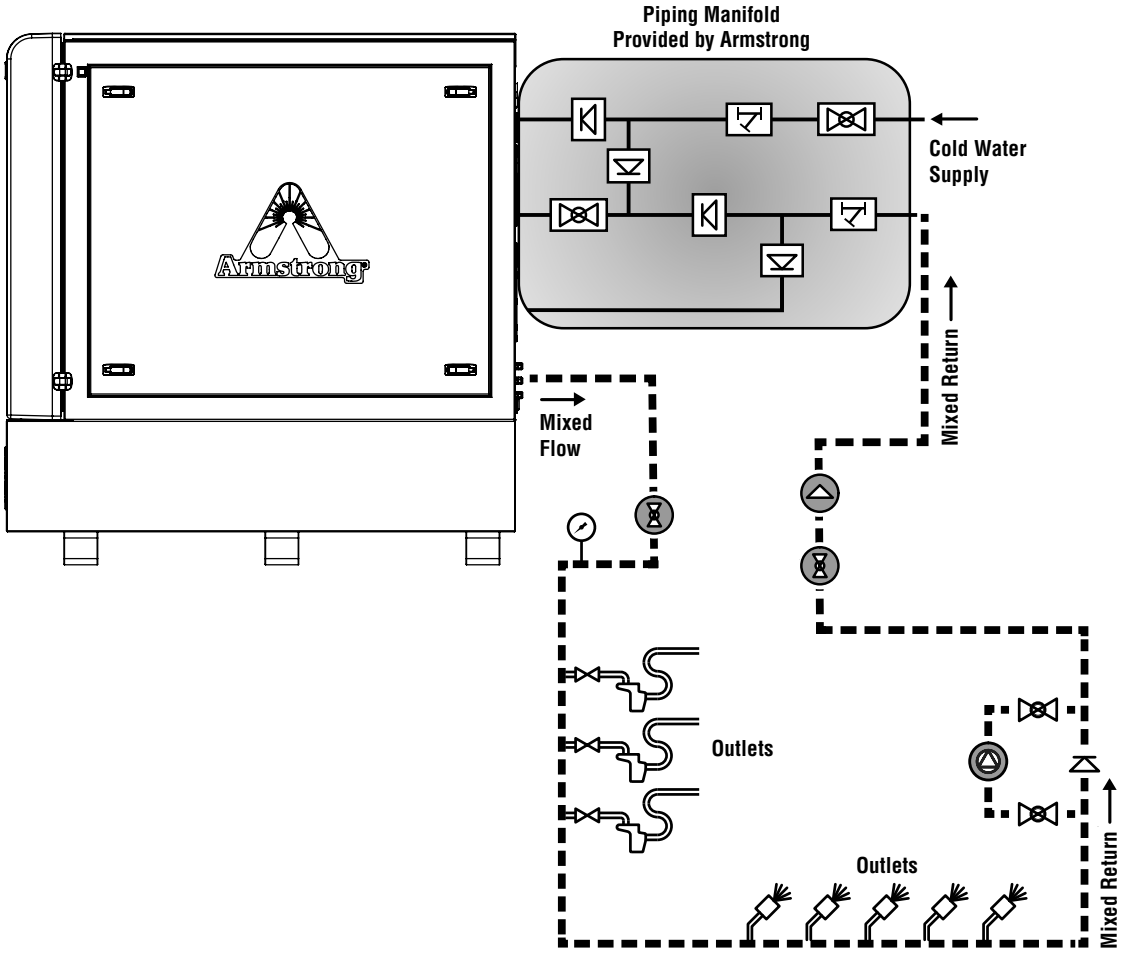
5.1 - Piping Diagram

System Layout

LEGEND

- Recirculation Pump
- Check Valve
- Stop Valve
- Isolation Valve
- Sink
- Shower
- Thermometer
- Strainer
- Cold Water
- Hot Water
- Mixed Water

Items in gray circles are installer supplied



Piping, cont.

5.2 - ASCEND® Multi-Unit Strategy

Unit Scenarios

Assumes each unit has its own DRV, that outlets are piped together, and that recirculation is brought back and split between each unit via a balancing valve (the same way we do with Digital Mixing Centers)

A. Full, 100% Back Redundancy

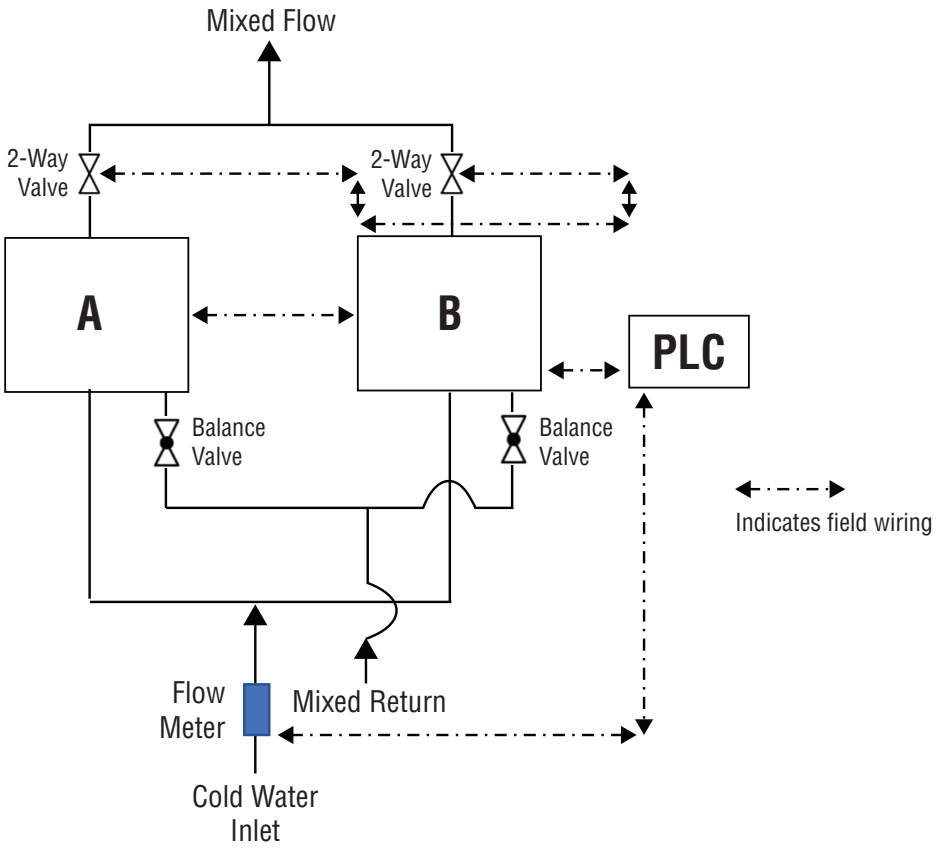
- Each unit is completely manually isolated and powered on/off

B. Full, 100% Running for Capacity

- Each unit is completely manually isolated and powered on/off. Both units are running 100% independently of one another.

C. One Unit as Back Up or Capacity

- PLC, 2-way solenoid valves, and flow meters used
- Error code and flow rate logic:
  - If the unit is in error: Shut down the unit and close its 2-way valve. Turn the back-up unit on and open its 2-way valve
  - If Error code clears: Turn the unit on and open its 2-way valve. Turn the back-up unit off and close its 2-way valve
  - If Flow Rate ≥ (MAX. CAPACITY OF 1 UNIT): Turn the back-up unit on and open its 2-way valve
  - If Flow Rate ≤ (MAX. CAPACITY OF 1 UNIT): Turn the back-up unit off and close its 2-way valve



Piping, cont.

ASCEND® 1000 and ASCEND® 1500 have DRV40 on-board

- Minimum flow for each heater is 5 GPM. If two heaters are operating in parallel, minimum flow is 10 GPM and each DRV must have a balancing valve.

ASCEND® 800 has DRV25 on-board

- Minimum flow for each heater is 2 GPM. If two heaters are operating in parallel, minimum flow is 4 gpm and each DRV must have a balancing valve.

Armstrong will supply PLCs as called for in Scenario C as well as provide parts for piping.

- Armstrong will supply all parts, but ASCEND® multi-unit installs should be piped in the field, as it would be difficult to predict the layout and orientation of a system.

What ASCEND® is NOT:

- No combi systems, i.e. domestic water and boiler heating, or domestic water and spa/pool heating
- No ABH-XL plus ASCEND^0 combinations - each system will either be entirely ABH-XL or entirely ASCEND®
- No split model/capacity systems (i.e. ASCEND® 800 and 1000) - each unit must be the same size

6.0 - Start-Up Procedures

6.1 - Items to Be Checked Before Lighting the Appliance

It is recommended that you read this entire section of Start-Up Procedures to get a better understanding of how the appliance operates before you start the unit and use (Start-Up Checklist) as a check and to document and confirm all conditions are correct. All appliance start ups should be conducted by properly qualified professionals.

1. Make sure that you follow the lighting instructions before running the appliance.
2. Check and make sure the circulating pump is running, and that the pressure transducers and/or flow switch are operating correctly.
3. Make sure that the Gas is turned on outside the rear of the cabinet of the appliance.
4. Double check to be sure the temperature setting is correct.
5. Make sure the unit is properly grounded and the electrical wiring meets the electrical requirements detailed in **Section 2.1**.
6. Make sure that no valves are placed between the relief valve and the appliance. The relief valve must be installed in such a manner that the discharge will be conducted to a suitable place for disposal when relief occurs. Ensure that no reducing coupling or other restriction is installed in the discharge line, and that the discharge line is installed to allow complete drainage of both the valve and the line.
7. Turn on the power to the appliance. The Setpoint Temperature of the appliance will appear in the display at this time. If a fault code appears, correct the fault before operating. The appliance will now run its pre-purge and ignition cycles, then begin heating, which will be indicated by the orange flame in the lower right corner of the display.

6.2 - Lighting Instructions

1. This appliance does not have a pilot light. It is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.
2. BEFORE OPERATING smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.

WARNING!

If you do not follow these instructions exactly, a fire or explosion may result, causing property damage, personal injury, or loss of life.

WHAT TO DO IF YOU SMELL GAS:

- Do not try to light any appliance.
- Do not touch any electric switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas suppliers' instructions.
- If you cannot reach your gas supplier, call the fire department.

Start-Up Procedures, cont.

3. Turn on gas shutoff valve (located outside the cabinet on the rear of the appliance) so that the handle is aligned with the gas pipe. If the handle will not turn by hand, don't try to repair it; call a qualified service technician. Force or attempted repair may result in a fire or explosion.
4. Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water.
5. The appliance shall be installed so the gas ignition system components are protected from water (dripping, spraying, rain, etc.) during appliance operation and service (circulator replacement, condensate trap, control replacement, etc.).

6.3 - Operating Instructions

1. **STOP! Make sure you have read the safety information above.**
2. Turn off all electric power to the appliance.
3. This appliance is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.
4. Turn gas shutoff valve clockwise to "off" —do not force it.
5. Wait five (5) minutes to clear out any gas. If you then smell gas, STOP! Follow the instructions from Section B: Lighting Instructions in the safety information. If you don't smell gas, go to the next step.
6. Turn the gas shutoff valve counter clockwise to "on."
7. Turn on all electric power to appliance.
8. Set the thermostat to the desired setting.
9. If the appliance will not operate, follow the instructions to turn off the gas in **Section 7.6** and call your service technician or gas supplier.

6.4 - INI Process and Service Procedures

The HOT™ Controls, contain a unique function, they track the accuracy, degradation and fouling of all connected sensors and pressure transducers and the major components of the system; appliance heat exchanger, fan, pump and igniter.

This tracking is accomplished by taking readings of and creating trend lines for each mentioned item and then running calculations of some versus others to determine how the need for maintenance of specific components is progressing.

Aside from the use of up to 11 different sensors to monitor items like incoming gas and leaving fan pressure and pressure at the exiting side of the heat exchanger and condensate drain connection, we have an initialization (INI) process that takes place automatically in the background to collect this data during steady state conditions and record it, to populate the trend lines.

The creation of a baseline: Zero INI (Z-INI), is an important step in this process and normally occurs during the commissioning of the system. Within 2 minutes of powering the appliances up, a question will be presented on screen: "A ZERO INI IS REQUIRED—RUN NOW?" YES or NO, unless the entire system is fully commissioned and operating normally, answer NO. The question will be presented every 15 minutes until you finally select "YES". It is best not to answer YES until all appliances are started and combustion set. When they are all ready, turn off power to all at the switch on the front near the display. Go back to the appliance with two displays, power it and all others on, and when the question is presented again (two minutes or less), answer YES on each individual appliance. The Z-INI should be completed in less than 10 minutes.

If you end up with the Z-INI running when things are not quite 100% as they will be when the system is up and running, not to worry, with the proper password, you can overwrite the Z-INI with a replacement, so you are sure your Z-INI is a true baseline to work from.

Start-Up Procedures, cont.

To force an INI to run, follow the procedures below. This can be done by all appliances in the cascade or individually.

1. Enter Setup menu
2. Press the back and down arrow simultaneously for 3 seconds to enter the password screen, and enter password level 1 (there is an advanced Level 2 with more options, available if you have attended training at the Manufacturer's factory). - Installer level – EAZ1LVL
3. The setup screen will now have additional selections, scroll down to start INI (be sure only to select Zero if you have had a commissioning issue and need an updated proper baseline to work from), and select it.
4. The INI is now in progress, and will end after a few minutes at which point normal operation will resume. A scrolling message across the bottom of each appliance (if in a Cascade) will indicate it is in process.

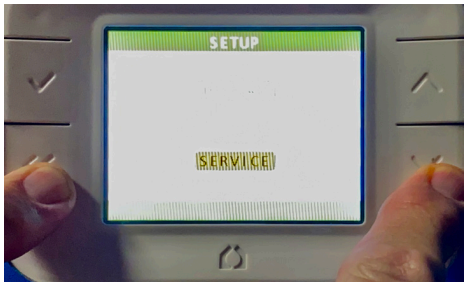
Note that the INI process normally occurs in the background, during no call for heat and is rarely noticed. Subsequent INI's happen on a pre-determined basis; they are based on parameter IN1 setting of 1 – 30 days and therefor can be adjusted to fit the environment of the installation. If, you have an operation that requires heat 24 hours a day, when the system setting of days between INI's has been reached, and there is a burn cycle in process, the controls will look to parameter IN2; waiting hours of burn time before a forced INI occurs; default setting of 2.5 hours. When that quantity of hours has been reached after the days between setting, a forced INI will occur.

A forced INI occurs like this; the burners of all appliances in the Cascade (or the stand alone appliance) are shut down, the pump is run until the gradient (moving temperatures) between the Inlet (T2) sensor and the outlet (T1.2) sensor is less than parameter IN3; with a default setting of 0.36°F/second ΔT. At the moment that setting has been reached, the INI process begins and will take a minimum of 3 minutes for a stand-alone or dual appliance system, and 7 – 8 minutes for up to 8 appliances in the Cascade.

The Cascade operating control remembers the settings of all running appliances prior to the forced shut down and immediately following the INI, it returns to those firing rates to minimize any drop in system water temperature.

From the Home screen, you can navigate to the HISTORY tab, select it and tab down to INI DATA, there you can view the recorded INI data from record 00 (Z-INI) through the last 9 that have been recorded. This is the data that decisions and notifications (if opted for) will be sent based on.

1



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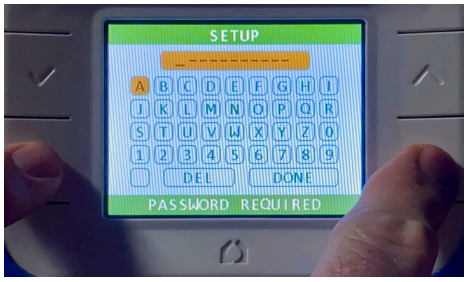

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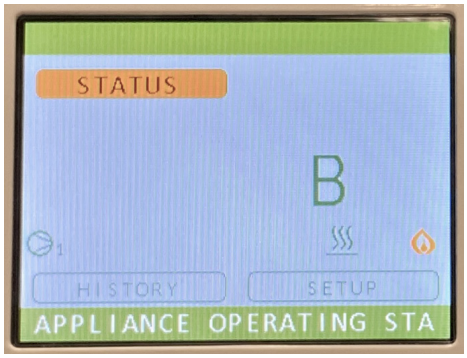

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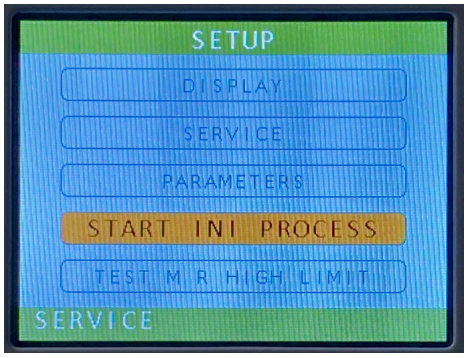

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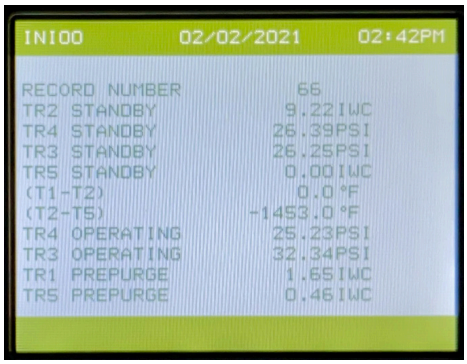


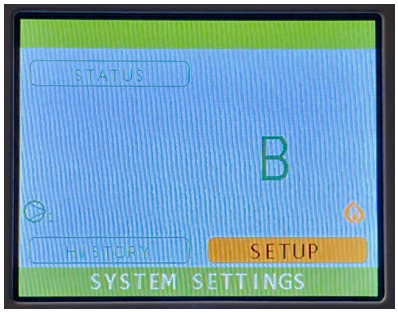
Start-Up Procedures, cont.

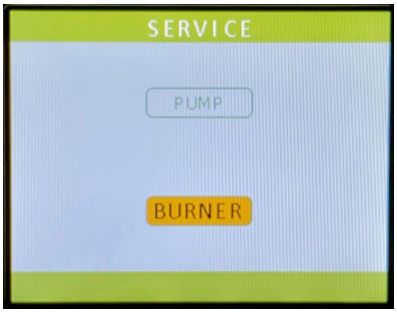
Start Service Mode Procedure:

1. Enter Setup menu
2. Scroll down to service, and select using the ✓ button
3. Select burner, and then start
4. The display will return to the setup menu, and service mode has begun. Select service again, and then burner.

   There will now be a new options in place of start, stop & speed. Set speed to 50% using the up and down arrows., using 100% for high fire set up and minimum for low fire set up.
5. Return to the home screen and select status.
6. When the status screen appears, press the down arrow once to show screen 2, showing fan speed and flame signal.
7. From here, you can watch the fan during pre-purge and ignition, as well as the flame signal strength at ignition.
8. Return to the home screen after ignition, and a flame icon in the lower right corner shows the burner on status.
9. Return to the service speed function, and adjust fan speed as needed.
10. Service mode will last for 40 minutes, or until canceled. To cancel the service function, select stop from the service menu.

1





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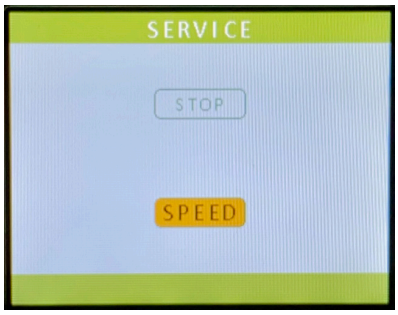

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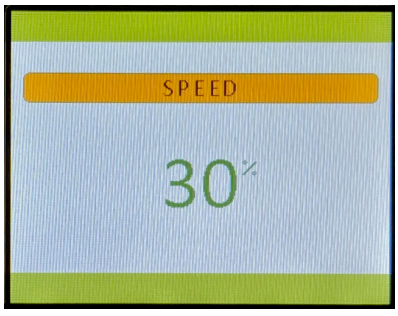

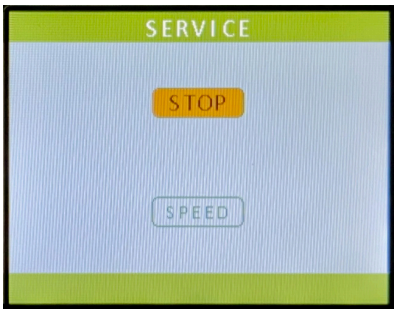

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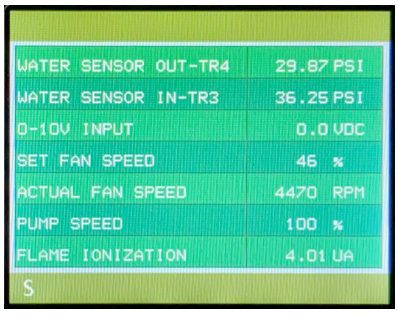
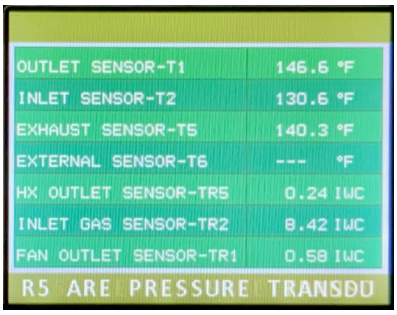




Start-Up Procedures, cont.

6.5 - Adjusting the Temperature on the Appliance Display

On a single unit, the set point is adjusted through the BDB. For multiple unit systems, the set point is adjusted through the CDB.

Enter the menu labeled Setpoint in the upper right of the display to set the desired operating water temperature. On a boiler, this will be based on the leaving water temperature. On a water heater it will be based either on a connected external (storage tank) sensor, or, if there is none connected, it will operate based on the incoming water temperature. The range is factory-set at 50–160°F (10–71°C) for water heaters and 50–195°F (10–90.6°C) for boilers. Other special ranges are available by contacting the factory. **If other temperature settings are required, contact the Manufacturer.** Other special parameters may be set by entering a password in the display, varying from end user, installer, advanced, and factory levels. The display can show either °F or °C set in the setup menu, then display options.

SET POINT GLOSSARY

Heating = System setpoint in CH

Heating Reduced = System setpoint in CH during night setback hours

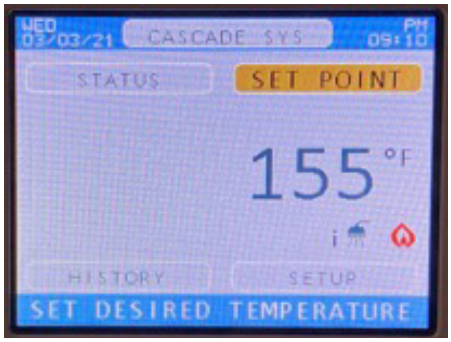
Boiler for heating = System setpoint in CH when multiple applications are heated.

iDHW Hot Water Tank = Storage tank setpoint for iDHW

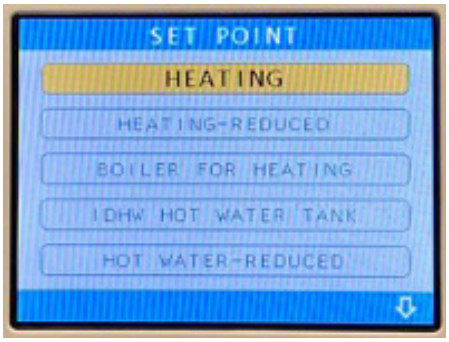
Hot Water Reduced = iDHW during setback hours.

Boiler for iDHW Load = System setpoint during iDHW demand.

Home Screen / Set Point



Page 1 of options



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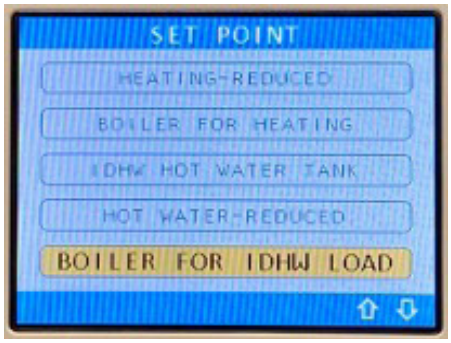
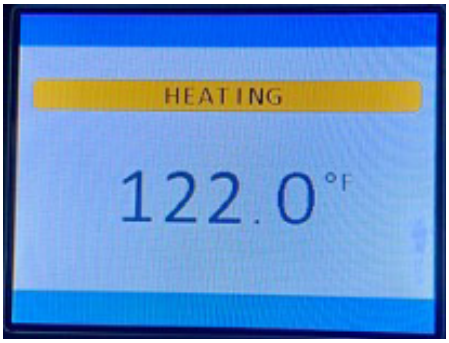
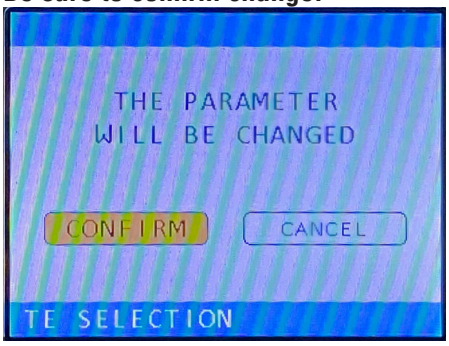


Temperature setting screen:



Be sure to confirm change:



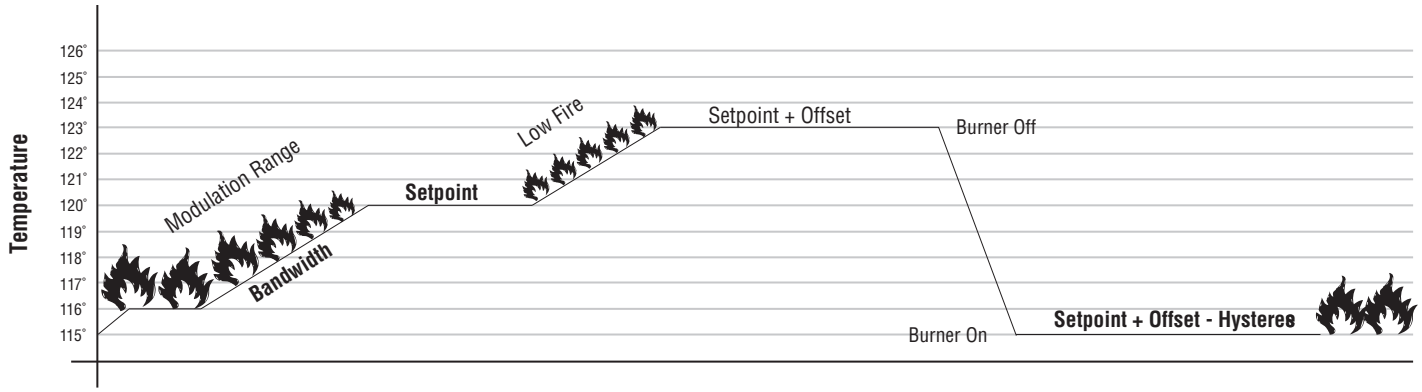
Start-Up Procedures, cont.

Water Heating Operating Sample

All of the following parameters are controlled by a storage tank temperature sensor:

- Setpoint = Target Temperature (120°F) Low fire only above this point
- Offset = Off Setpoint (3) = 123°F off
- Hysterese = On Setpoint (8) (120 + 3 - 8 = 115°F)
- Proportional Band = Modulation range (4) (120 - 4 = 116°F, modulation begins)

The appliance turns on at 115°F and when the temperature reaches 116°F the flame will begin to modulate down (approximately 25% of the modulation range per degree F of increase in this example). At 120°F, it will be at low fire and will remain there unless the temperature drops below 120°F and it will modulate back up. If it continues to increase, it will shut down at 123°F.



Start-Up Procedures, cont.

6.6 - Sequence of Operation

DANGER!

WATER TEMPERATURE OVER 125ºF CAN CAUSE SEVERE BURNS INSTANTLY, OR DEATH FROM SCALDS. CHILDREN, THE DISABLED, AND THE ELDERLY ARE AT HIGHEST RISK OF BEING SCALDED. SEE INSTRUCTION MANUAL BEFORE SETTING TEMPERATURE AT WATER HEATER. FEEL WATER BEFORE BATHING OR SHOWERING! TEMPERATURE LIMITING VALVES ARE AVAILABLE.

1. When power is first applied to the control, after an initialization phase, the control display will read the temperature Setpoint. The control will initially run through a self-diagnostic routine and then go into its aeration operating mode, where it bumps the pump on and off multiple times to purge the heat exchanger of any air that may have settled there while the power is off. If there is no call for heat, the system will go into an idle state. **NOTE: The cap on the Automatic Air Vent (if used), located on top of the appliance must remain in the loose state in order for the air to escape as required.**
2. If the thermostat is calling for heat, the control module will determine if the water temperature is below the programmed set point value minus the switching differential. It will then initiate a heating cycle.
3. The control then performs selected system diagnostic checks. If all checks are successfully passed, a pre-purge cycle is initiated (the blower will be on at 80%).
4. When the pre-purge period is complete, power is applied to the spark ignitor for 4.5 seconds. Approximately 1/2 second later, flame is verified. If a flame is not verified during the trial-for-ignition, the gas valve is immediately closed and the control will return to Step 3. After four trials, if a flame is not verified, the control will go into a lockout mode. If a flame is confirmed, the control enters the heating mode. The firing rate will be based on the control's proprietary algorithm.
5. When water temperature reaches the temperature set point value, the burner will be at minimum firing rate.If,when firing at minimum rate, it reaches temperature setpoint plus offset, the gas valve closes and the control enters a post-purge state (the blower will be on at 80%). At any time if an external thermostat is being used and becomes satisfied, the gas valve will be closed immediately.
6. When the post-purge is complete, the control enters an idle state while continuing to monitor temperature and the state of other system devices. If a call-for-heat is received, the control will automatically return to Step 2 in sequence and repeat the entire operating cycle.
7. Built in freeze protection: all models will automatically turn the pump on if the heat exchanger reaches 41°F (5°C) and the burner if it reaches 37°F (2.8°C), it will turn off at 50°F (10°C). **NOTE: Power must be left on for this protection to function. During the idle state and heat state, if the control detects an improper operating state from external devices, such as the high-limit switch, the control will illuminate an error code in the display.**

6.6 - Sequence of Operation

Direct Control

In the situation where direct control of the appliance is desired (such as from a Building Management System), the appliance can be programmed to receive a 0–10 volt DC signal to control operation. Note: This operation is only possible in individually-controlled units (i.e.: not Cascaded) and when each is individually vented.

There are two variations of this kind of external control (see Parameter S-18): Load Control and Set Point Control. In Load Control, the voltage signal controls the burner firing rate. In Set Point Control, the voltage signal controls the temperature set point of the appliance. (This is similar to how the appliance is controlled when operating without an outside signal.)

Setting up Direct Control

There are three steps required to set up this mode of operation. First, connect the incoming voltage signal to pins 5 and 6 on the terminal strip. Next, remove the jumper from the remote thermostat terminals (pins 11 and 12. If this is not done, the

appliance will fire based on its internal set point when the voltage drops below 1.0VDC. If the appliance is set up with any other external signal here, this should be removed as well, or that external signal will take over when the 0-10VDC control signal drops below 1.0VDC.

Next, go to Parameter S18 (PS18) in the Parameter menu and choose the appropriate control setting. (include picture of menu or HMI page)

The PS18 settings are:

- 0=Off (default setting--no external control, any external voltage signal ignored)
- 1=Load Control
- 2=Set Point Control

Load Control Mode (PS18=1)
When a 0-10VDC input is used for load control, the range of 0-10VDC corresponds directly to a modulation percentage (burner firing rate). An input of 10.0VDC results in the maximum default fan speed (modulation) for that appliance, and 1.0VDC results in the minimum default fan speed. The fan speed displayed on the appliance will depend on the range of the fan for that particular appliance.

Type	Minimum Fan Setting (1.0VDC)	Maximum Fan Setting (10.0VDC)	Voltage Increment
800	33%	100%	7.44%
1000	31%	100%	7.67%
1500	24%	100%	8.44%

The following is an example of the effect of changing the voltage signal on an appliance in Load Control mode:

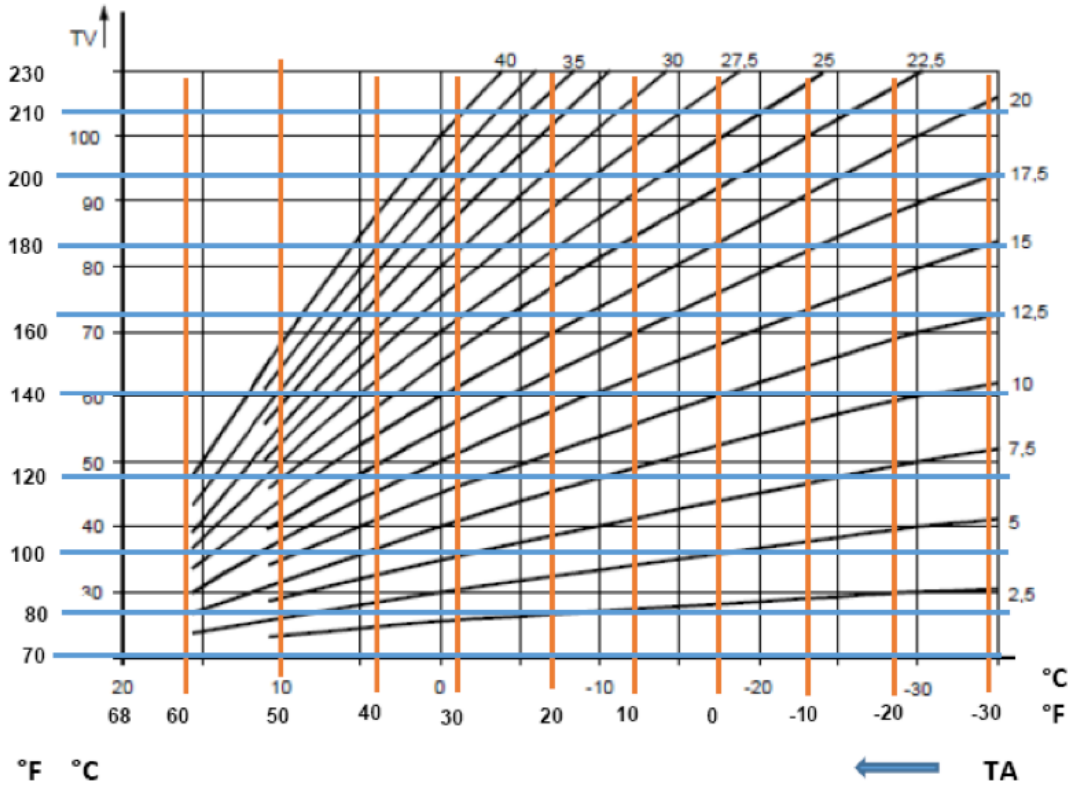
- The operational range of an 800 fan is 33%—100%
- 0 - 0.9V = Appliance off
- 1.0V = 33% Fan speed
- 1.3V = 35% Fan speed (3% modulation)
- 4.0V = 55% Fan speed (33% modulation)
- 6.8V = 76% Fan speed (64% modulation)
- 8.9V = 92% Fan speed (88% modulation)
- 10.0V = 100% Fan speed (100% modulation)
- Each volt = 7.44% fan speed or 11.1% modulation

Set Point Control Mode (PS18=2)
When a 0–10VDC input is used for Set Point Control, the range of 0–10VDC corresponds directly to the temperature set point. Contact customer support for assistance with using this mode as multiple parameters may be modified to alter bandwidth and set point sensitivity.

Start-Up Procedures, cont.

6.7 - Outdoor Reset Function

Curve or slope—set using the display option in heating set point.



1. You must have the Outdoor Sensor (10K) sensor installed, and the power must have been cycled off and on after its installation.
2. Set the outdoor curve parameter using the chart in Figure 6-1 (TA = outdoor temperature, TV = boiler water temperature), default is 180°F (82.2°C) water at -10°F (-23.3°C) outdoor—slope of 18.
3. Set the Warm Weather Shutdown temperature (default is 64.4°F (18°C); above this temperature, there is no call for heat.
4. Set the building type correction factor (if desired); default is 1.0:
   - Old building, not insulated
   - Building with thick walls >12 inches
   - Normal building, normal insulation
   - New building, well insulated
5. For comfort adjustment after start up, an additional boiler water temperature offset (either higher or lower) is also available in the set up screen, up to 18°F (-7.8°C) higher or lower than the curve calculation.

7.0 - Service and Maintenance

7.1 - Servicing the Appliance

1. Shut off the power supply to the appliance (See **Section 1.4**).
2. Turn the front cover security latch.
3. Undo the two latches at the bottom of the cover (if applicable).
4. Remove the cover.

7.2 - Placing the Appliance into Normal Operation

1. Replace the front cover in the normal position.
2. Close the security latch.
3. Turn on the power supply to the appliance.

To enter manual firing operation, enter SERVICE, in MODE - See **Section 6.4**.

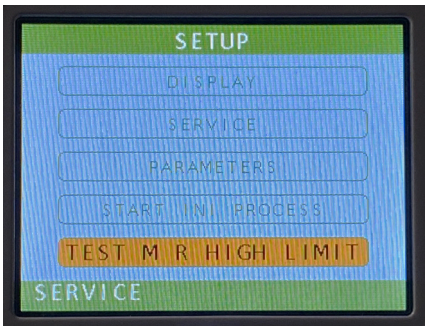
7.3 - Testing the Manual Reset High Limit

The HOT™ Controls (.2 configuration), contain a unique function, they use both pressure transducers and temperature thermistors to monitor appropriate flow through the heat exchanger of the appliance. The .3 configuration uses a water flow switch. In both configurations, there are two high limit sensors, both are set through parameters, however, only one requires a manual reset when it is tripped, and often requires an annual test to confirm its proper operation.

To test the manual reset high limit:

1. Enter Setup menu, then enter the Password, then Test M R High Limit
2. Set the temperature you want the MHRL to open at, it will show the current setting as a default, you should select a temperature less than that to complete the test without overheating the hot water system, just push the down arrow until the appropriate temperature and then push ✓

1



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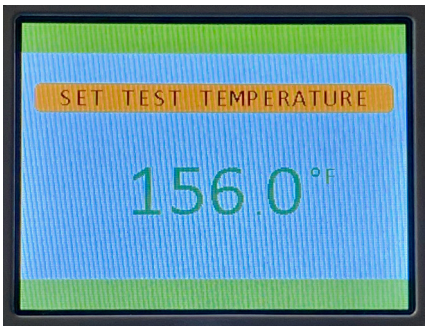
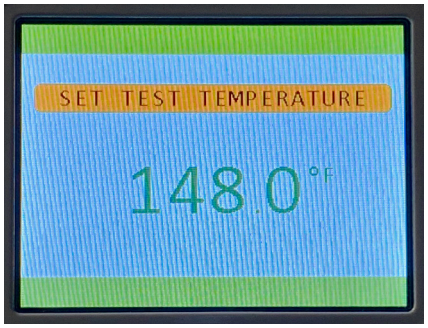
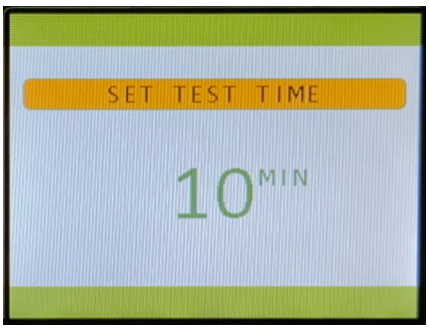


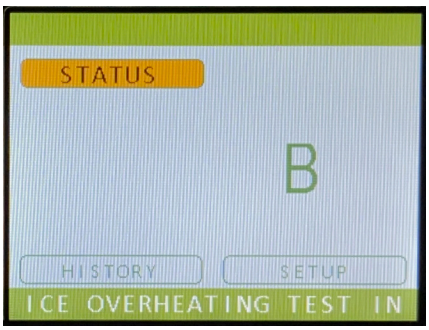


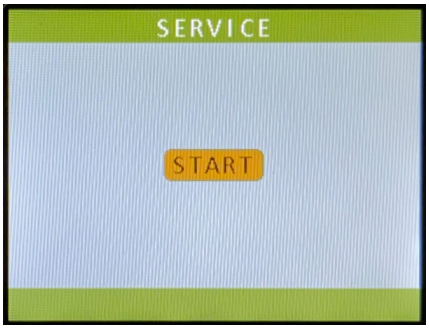
Service and Maintenance, cont.

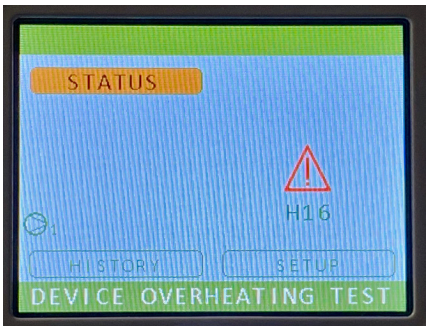
3. The high limit test is only active for 10 minutes as a default, you can select a time less than that if desired, just push the down arrow until the appropriate time and then push ✓:
   - The fact that the test is in progress will be indicated on the home screen scrolling message at the bottom, while it is active:
   - You may also place the appliance in SERVICE MODE now to get the appliance to run at a higher firing rate and surpass the temporary MRHL setting sooner.
   - When that setting is exceeded, the unit will shut down immediately and indicate a Hard Lock Out and H16 code. It will need to be reset to allow normal operation.
   - Note that if you reset it right away and you have not reached the number of minutes you set for the test period and the temperature is now below your test setting and below your setpoint, it will run and likely trip again.

3









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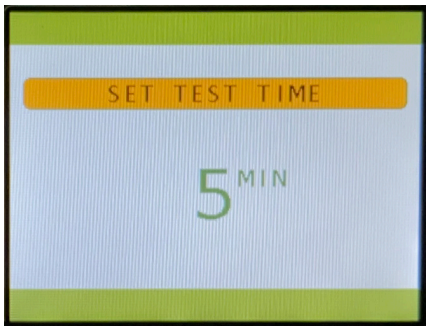
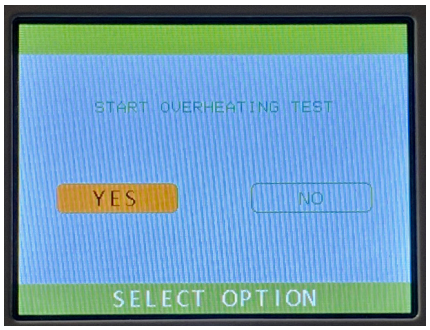
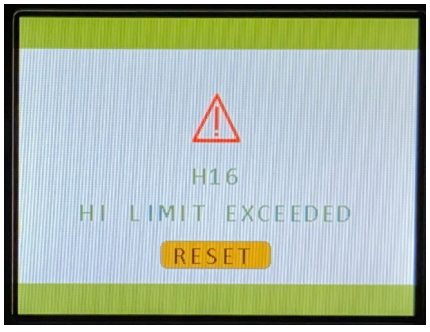






7.4 - Soft Lockout Codes (See Section 1.5 for Sensor Locations and Uses)

7.4.1 - CCB Soft Lockout (SLO) Codes

Code	Cause	Recommended Action
CCB01	Sensor S1 fault	Check that the S1 sensor is connected
CCB02	Sensor S2 fault	Check that the S2 sensor is connected
CCB03	Sensor S3 fault	Check that the S3 sensor is connected
CCB04	Sensor S4/SZ1 fault	Check that the S4/SZ1 sensor is connected
CCB05	Sensor S5/SZ2 fault	Check that the S5/SZ2 sensor is connected
CCB06	Sensor S6 fault	Check that the S6 sensor is connected
CCB07	Sensor SZ3 fault	Check that the SZ3 sensor is connected
CCB08	Sensor zone 4 fault	Check that the zone 4 sensor is connected
CCB09	Sensor zone 5 fault	Check that the zone 5 sensor is connected
CCB10	Sensor zone 6 fault	Check that the zone 6 sensor is connected
CCB11	Sensor zone 7 fault	Check that the zone 7 sensor is connected
CCB12	Sensor zone 8 fault	Check that the zone 8 sensor is connected
CCB15	Communication error via Modbus programming	Quantity of programmed appliances does not match quantity of connected appliances.
CCB20- CCB27	Communication error with a specific appliance; A = CCB 20… H = CCB 27	Check specific appliance to see that it is powered on, if yes, then check all communication connections at display andmain boards
CCB200	EEPROM fault	Check that the EEPROM is connected properly

7.4.2 - BCB Soft Lockout (SLO) Codes

*Codes may appear with an A, B, or C as a suffix denoting the number of times the code has appeared since thelast Initialization (INI). Some SLO's are accompanied by a reduction of the maximum firing rate; A=80%, B=50%,C=30%. After the C suffix appears, the next code of that kind becomes an HLO (manual reset required).

Code	Cause	Recommended Action
A1*	Excessive pressure differential (ΔP) on water side of heat exchanger	Check for scaling or blockage on water side of heat exchanger, also check pump performance. If this SLO is indicated while the unit is firing, it is doing so at a reduced BTU input; low enough to stay below that maximum ΔP set point.
B01	Pressure too high at condensate drain connection during Stand By	Look for condensate backing up into combustion side of heat exchanger.
B02	Pressure too high at condensate drain connection during pre-purge`	Insure condensate drain system is flowing freely, and vent is clear of obstructions. Also, be sure the Z-INI has been initiated.
B03	Pressure too low at condensate drain connection during pre-purge	Check for condensate (water) in the condensate neutralizer (if equipped) or the condensate trap at appliance outlet. If it is dry, add water to form trap. The appliance also will initiate an auto-filling process for the condensate trap, indicated on the screen during this operation. Also, be sure the Z-INI has been initiated.
B04	Pressure at flue/condensate sensor is too low	Check flue gas vent connection or sensor connection located at condensate drain line. Also check for a disconnected or open condensate drain line and last, look for a leak in the heat exchanger outer casing (behind the insulation).
DW7*	Temperature rise (ΔT) through heat exchanger is too high	Unit is operating at a reduced BTU input - check for scaling or blockage on water side of heat exchanger, also check pump performance.
FL05*	Flue gas temperature too high	Unit is burning at a reduced BTU input rate. The cause of the high flue gas temperature should be investigated and corrected ASAP
FL09*	Fouling of the fire side of the heat exchanger	Unit is burning at a reduced BTU input rate. A combustion side inspection and cleaning should be scheduled ASAP.
FL13	Flue gas sensor (T5) fault (not connected or open status)	Check the condition of the connectors and wires from the card edge connector at the board to the flue gas sensor on the appliance.
FL14	Flue gas sensor (T5) fault (short circuit status)	Take an OHM reading at the connector on the flue gas sensor - compare it to the chart in Section 7.9 and replace if out of range.
G01*	Gas supply pressure too low	If this occurs at the beginning of an ignition cycle, this SLO will stay until the pressure is high enough for proper ignition. If this occurs while the unit is firing, and it continues to fire, it is doing so at a reduced BTU input low enough to stay above that minimum pressure set point.
H01	Outlet sensor (T1.1, 1.2) fault (not connected or open status)	Check the condition of the connectors and wires from the card edge connector at the board to the outlet sensor on the appliance.
H02	Inlet sensor (T2) fault (not connected or open status)	Check the condition of the connectors and wires from the card edge connector at the board to the inlet sensor on the appliance.
H04	Outlet sensor (T1.1, 1.2) fault (short circuit status)	Take an OHM reading on the outlet sensor - compare it to the chart in Section 7.9 and replace if out of range.
CCB200	EEPROM fault	Check that the EEPROM is connected properly

Service and Maintenance, cont.

Code	Cause	Recommended Action
H05	Inlet sensor (T2) fault (short circuit status)	Take an OHM reading on the inlet sensor - compare it to the chart in **Section 7.9** and replace if out of range.
H07/09	Calibration between inlet (T2) and outlet (T1) water temperature sensors indicates too great a differential.	Test both sensors against the actual temperature and OHMs as shown in the chart in **Section 7.9** and replace if out of range. The appliance will continue to operate, but at a reduced input until the required correction has been resolved.
H11	High ΔT	See Section 7.6
H24*	High Limit set point has been exceeded	Appliance restarts, but at a reduced input; after 3 restarts, the appliance gets a Manual Lock Out (HLO) and needs the cause resolved immediately. Possible causes are high ΔT, temperature setpoint versus high limit setting too close or bad sensor.
ID01	First INI process data missing	Run the Z-INI; starting Initialization numbers must be tested and the saved for all connected sensors in a number of conditions.
ID02	EMB EEPROM fault (2)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID03	EMB EEPROM fault (1)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID04	Internal fault (gv1)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID05	Internal fault (gv2)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID06	Internal fault (gv3)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID09	Fan speed error	Cycle power off, check the four-wire fan connection; wires and each end at connectors. If all ok, cycle power back on and if fan Speed error reappears, replace fan.
ID11	Flame proof indicated without flame present	Cycle power off, check Igniter, Ignition cable and cable ends, if moisture present, dry thoroughly. Cycle power back on.
ID13	Low voltage to appliance	Check voltage - this fault occurs when the supply voltage is more than 10% less than rated supply.
ID14	High voltage to appliance	Check voltage - this fault occurs when the supply voltage is more than 15% greater than rated supply.
ID16 A	External sensor (T6) fault (not connected or open status)	Check the condition of the connectors and wires from the card edge connector at the board to the terminal strip to the external sensor in the piping or Low Loss Header.
ID16 B	External sensor (T6) fault (short circuit status)	Take an OHM reading on the wires from the external sensor in the piping or low lass header - compare it to the chart in **Section 7.9** and replace if out of range.
ID19 A	Tank sensor (T3) fault (not connected or open status)	Check the condition of the connectors and wires from the card edge connector at the board to the terminal strip to the storage tank sensor.
ID19 B	Tank sensor (T3) fault (short circuit status)	Take an OHM reading on the wires from the storage tank sensor - compare it to the chart in **Section 7.9** and replace if out of range.
ID20 A	Outdoor sensor (T4) fault (not connected or open status)	Check the condition of the connectors and wires from the card edge connector at the board to the terminal strip to the outdoor air sensor.
ID20 B	Outdoor sensor (T4) fault (short circuit status)	Take an OHM reading on the wires from the outdoor air sensor - compare it to the chart in **Section 7.9** and replace if out of range.
ID80	Boiler is configured for cascade, but no cascade manager present	Check settings in individual appliance parameter S25; should be a different value in each appliance between A–H. NOTE: There should not be a SET POINT option available on the home screen of the appliance if S25 is set properly.
ID87	Actual fan speed is lower than specified fan speed, during speed up.	The appliance is waiting to allow the fan time to reach the required rpm, if it does not achieve it in 30 seconds, ID88 will become the new fault code.
ID88	Actual fan speed did not reach required rpm in the time allotted.	If the actual fan speed is more than +/- parameter F20 rpm off the set fan speed after pre-purge time ID88 is shown. This fault will correct itself after the correct fan speed is achieved.
ID89	T1.1-T1.2 ΔT fault	The ΔT on the duplex outlet sensor (T1.1 & T1.2) is greater than 18°F. Test both sensors against the actual temperature and OHMs as shown in the chart in **Section 7.9** and replace if out of range.
ID95	EEPROM key blank	EEPROM key is blank with no data
ID97	EEPROM key missing	EEPROM key is not connected or not communicating
P04*	No water flow from the pump	Check for pump electrical issues i.e. no power to the pump, pump motor is seized, pump is constantly powered and running.
P05*	Reduced water flow through appliance	Check for partially closed valves, pump impeller fouling etc. Appliance is operating at a reduced BTU capacity to avoid heat exchanger damage.
S13	Additional safety fault	Check the status of the additional safety input switch when call for heat is established, and P7 time elapsed, and continuously thereafter during a burn cycle.
W01*	Maximum water pressure exceeded	Water pressure too high (within 10% of pressure relief valve rating), confirm cause and correct. Unit is operating at a reduced BTU capacity to try and avoid the relief valve opening.
W04*	Water pressure is less than minimum setting	Water pressure too low (within 10% of minimum pressure required), confirm cause and correct. Unit is operating at a reduced BTU capacity to try and avoid any damage to the heat exchanger.

7.5 - Appliance Hard Lockout Codes

7.5.1 - BCB Hard Lockout (HLO) Codes

Code	Cause	Recommended Action
A1/A2	Excessive pressure differential (ΔP) on water side of heat exchanger	Check for scaling or blockage on water side of heat exchanger, also check pump performance.
B03	Neutralizer/trap has little or no Condensate (water)	Fill neutralizer (or trap if not a factory neutralizer) with water to avoid flue gases spilling into the room through a dry trap.
B04	Pressure at flue/condensate sensor is too low	Check flue gas vent connection or sensor connection located at condensate drain line. Also check for a disconnected or open condensate drain line and last, look for a leak in the heat exchanger outer casing (behind the insulation).
DW7	Temperature rise (ΔT) through heat exchanger is too high	Appliance has been through multiple tests and checks including operating at a reduced input to avoid this shut down. The ΔP across the heat exchanger indicates reduced water flow. Check the pump performance, check for partially closed valves and if all ok, perform a descaling operation on the water side of the heat exchanger.
FL01	Flue gas temperature has exceeded the maximum safe level set in the operating parameters	Flue gas temperature setting has been exceeded by a significant amount even after operation at a reduced firing rate. Check entire burner assembly, if ok, then a complete fire side cleaning must be initiated immediately.
FL05	Flue gas temperature too high	Unit is burning at a reduced BTU input rate. The cause of the high flue gas should be investigated and corrected ASAP—See FL01
FL09	Fire side of heat exchanger is severely fouled	Remove burner and check condition of fire side of tubes in the burner area.
G01	Gas pressure too low	Find cause of low pressure and correct; piping or regulator sizing is the general culprit
G03	Gas pressure too high during a burn cycle	Correct the cause of the high gas pressure - either adjust regulator or replace and repair as required - maximum allowed by code is 14"w.c.
H15/H16	Water temperature limit set point exceeded	Check set point(s), sensors, pumping etc. Correct cause of high water temperature
H24	Water Temperature Manual Reset High Limit set point exceeded	Check set point(s), sensors, pumping etc. Correct cause of high water temperature
ID01	First INI process data missing	Run the Z-INI; starting Initialization numbers must be tested and the saved for all connected sensors in a number of conditions.
ID02	EMB EEPROM fault (2)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID03	No valid data on microcontroller Flash memory	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID04	Internal fault (gv1)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID05	Internal fault (gv2)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID06	Internal fault (gv3)	Reset the fault, cycle power on and off, if the fault reappears, the EMB–EEPROM is corrupted.
ID09	Fan speed error	Cycle power off, check the four-wire fan connection; wires and each end at connectors. If all ok, cycle power back on and if fan Speed error reappears, replace fan.
ID12	Flue thermostat open.	Check for open flue temperature switch, if parameter S24=1
ID89	Fan is not running	Either fan is not running (check wiring or replace), or factory programming has been altered (consult factory).
ID96	Wrong EEPROM key connected	Install proper EMB EEPROM, if it cannot be found, contact the factory for assistance - be sure to have model and serial number of the appliance in question.
ID99	BDB Reset action finished	There have been too many resets, a concerted effort must be made to find the cause of the fault and correct it. This is a timed action, and the unit cannot be reset until the time has elapsed. Contact the factory with further questions. This fault will require both a power reset and then an on-screen fault reset via the HISTORY tab.
IG2/IG3	Too many restarts or relights after no-flame.	Appliance has been through multiple tests and checks including trying to ignite at different inputs to avoid this shut down. Combustion related items must be checked, including air/gas ratio, ignition cable and igniter. Check flow switch if installed.
IG4/IG5	Too many restarts or relights after no-flame.	Appliance has been through multiple tests and checks including trying to ignite at different inputs to avoid this shut down. Combustion related items must be checked, including air/gas ratio, ignition cable and igniter. Check flow switch if installed.
IG19	Too many attempts for ignition	Appliance has been through multiple tests and checks including trying to ignite at different inputs to avoid this shut down. Combustion related items must be checked, including air/gas ratio, ignition cable and igniter. Check flow switch if installed.
IG27	Too many attempts for ignition	Appliance has been through multiple tests and checks including trying to ignite at different inputs to avoid this shut down. Combustion related items must be checked, including air/gas ratio, ignition cable and igniter. Check flow switch if installed.
P04	Low or no water flow	Check for pump electrical issues i.e. no power to the pump, pump motor is seized, pump is constantly powered and running.
S13	Additional safety circuit (terminals 20, 21) open	Check flow switch, burner door and heat exchanger rear wall high temperature limits
P05	Water flow too low through appliance	Check for partially closed valves, pump impeller fouling, etc.
P06	Water flow blocked during burn cycle (proof of flow)	Check for partially closed valves, pump impeller fouling, etc.
W04	Minimum water pressure	Water pressure too low (within 10% of minimum pressure required)

Service and Maintenance, cont.

NOTE: In many cases, a "hard lockout" will indicate that there is something wrong with the appliance, that should be serviced or repaired.

EXAMPLE: If there is a loss of flow due to an air bubble passing through the appliance (sensed via the water pressure transducers), the appliance will shut down and display a temporary fault of P04 or P05 A, B, or C. When flow resumes and a waiting time has elapsed, the control board will perform a pre-start diagnostic and then resume a burn cycle.

7.6 - To Turn Off Gas to the Appliance

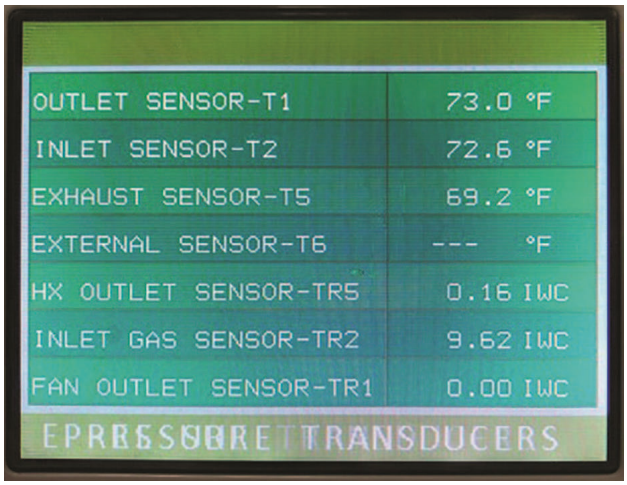
1. Set the thermostat to lowest setting.
2. Turn off power switch on front of unit.
3. Turn off all electric power to the appliance if service is to be performed.
4. Turn gas shutoff valve clockwise to "off." Handle will be horizontal. Do not force.

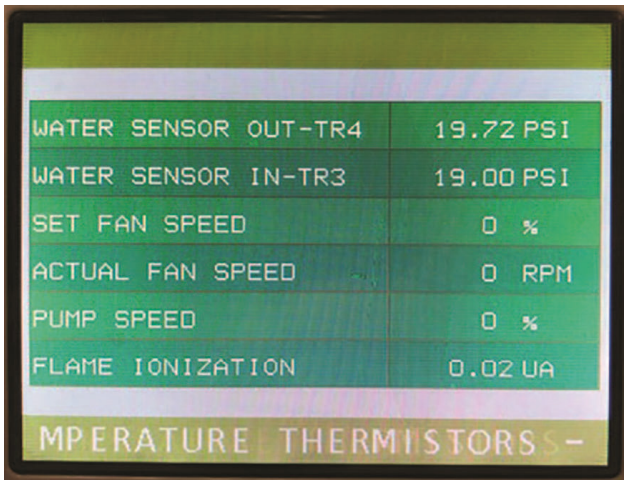
7.7 - Pump and Wiring Control

The appliance control board has an on-board relay for controlling the circulating pump. On a call for heat, the pump will start, allowing the water flow proving circuit to be made and the pre-start diagnostic to continue. After the call for heat has been satisfied, the pump will continue to run for the factory programmed period of time (1 minute) and then shut off. For water heating applications an external temperature sensor must be mounted in the water storage tank. For heating applications, the call for heat must come from an external source (room thermostat etc.).

Service and Maintenance, cont.

7.8 - Status Readings





Sensor list and other details on screens will vary from system to system

7.9 - Appliance Sensor Resistance Table

TEMPERATURE (OF)	RESISTANCE (OHM)	TEMPERATURE (OC)	RESISTANCE (OHM)
32	32550	0	32550
41	25340	5	25340
50	19870	10	19870
59	15700	15	15700
68	12490	20	12490
77	10000	25	10000
86	8059	30	8059
95	6535	35	6535
104	5330	40	5330
113	4372	45	4372
122	3605	50	3605
131	2989	55	2989
140	2490	60	2490
149	2084	65	2084
158	1753	70	1753
167	1481	75	1481
176	1256	80	1256
185	1070	85	1070
194	915	90	915
203	786	95	786

8.0 - Maintenance

8.1 - Periodic Maintenance and Inspections

All high efficiency condensing appliances will require more regular maintenance (cleaning) than their non-condensing counterparts. Failure to do so may result in damage to the appliance that is not covered under warranty. Failure to follow all of the instructions contained in this manual may also cause premature product failure that may not be covered under warranty.

Periodic maintenance should be performed at least once a year by a qualified service technician to ensure that all the equipment is in safe, efficient operation. **Failure to do so may eliminate warranty coverage.** In the first year of operation, it is highly recommended that inspections of all connection points and the combustion chamber be done at three month intervals, any signs of fouling or leaks must be thoroughly investigated immediately as failure to do so may void warranty. Assuming no cause for excessive fouling is found, then the period of months from initial start up that it was found that cleaning was required, shall become the required future minimum cleaning interval, but at no time should it exceed 12 months. The owner MUST make necessary arrangements with a qualified heating contractor for proper maintenance of the appliance. Installer must also inform the owner that the lack of proper care and maintenance of the appliance may result in a hazardous condition and lack of warranty coverage. The installer should discuss the contents of the User's Information Manual with the owner.

Maintenance, cont.

8.2 - Annual Inspection (See Maintenance Checklist for required tools and materials)

An inspection should cover, at a minimum, the following areas:

- Inspect all fittings, controls and connections for leaks, damage, or fouling
- Fire side: Heat exchanger, burner and ignitor, burner door and rear wall insulation
- Drain system components: Hoses and clamps, trap assembly, condensate neutralizer
- Test all safeties and operating controls
- Water side temperature rise (ΔT) test

Inspection and Cleaning

CAUTION: Before removing the door of the appliance, switch off the electrical power supply to it.

- Remove the front cover and check the sensors, transducers, all pipes, lines and connections, and the heat exchanger (top, bottom) for traces of water and water leakage.
- Inspect the top of the casing and/or the top of the appliance for water leakage or traces of water from the air supply pipe or the air vent (if applicable).

8.3 - Heat Exchanger Anti-Scaling Prevention Feature

The appliance controller contains sophisticated software that enables it to monitor the rate of temperature rise through the heat exchanger. By doing this, it greatly reduces the possibility of heat exchanger failure due to scaling or fouling. A set of parameters are programmed in at the factory, to provide a design temperature rise (ΔT) setting on each size unit that is fixed. The Anti-Scale is based on an increase over the design ΔT through the heat exchanger. This Anti-Scale is determined using the inlet and outlet sensors, even if a tank thermistor is being used. If the Anti-Scale setting is reached, the unit will display H11, shut down and not re-fire until it has cooled. The first 3 times this happens, there will be a reduction of the maximum firing rate. The fault will be accompanied by either an A, B, or C suffix, indicating a maximum firing rate of 80%, 50%, or 30% respectively. The control will go into hard Lockout after the C suffix is achieved, and have to be manually reset. Once the heat exchanger has been acid cleaned, contact the factory for instructions on resetting the unit for full rated BTU input. Typical causes for repeated H11 indications at start up are air trapped in the heat exchanger or contaminates lodging in the piping or heat exchanger during installation, both of these causes can generally be cleared by isolating the hot water system and flushing water at full city pressure through the drain valve or relief valve on the appliance outlet.

9.0 - Special Installation Requirements

9.1 - Installation Requirements (Massachusetts)

Requirements for Installation—Commonwealth of Massachusetts

For all side wall horizontally vented a. gas fueled equipment installed in every dwelling, building or structure used in whole or in part for residential purposes, including those owned or operated by the Commonwealth and where the side wall exhaust vent termination is less than seven (7) feet above finished grade in the area of the venting, including but not limited to decks and porches, the following requirements shall be satisfied:

1. **INSTALLATION OF CARBON MONOXIDE DETECTORS** At the time of installation of the side wall horizontal vented gas fueled equipment, the installing plumber or gas fitter shall observe that a hard wired carbon monoxide detector with an alarm and battery back-up is installed on the floor level where the gas equipment is to be installed. In addition, the installing plumber or gas fitter shall observe that a battery operated or hard wired carbon monoxide detector with an alarm is installed on each additional level of the dwelling, building or structure served by the side wall horizontal vented gas fueled equipment. It shall be the responsibility of the property owner to secure the services of qualified licensed professionals for the installation of hard wired carbon monoxide detectors.
    a. In the event that the side wall horizontally vented gas fueled equipment is installed in a crawl space or an attic, the hard wired carbon monoxide detector with alarm and battery back-up may be installed on the next adjacent floor level.
    b. In the event that the requirements of this subdivision can not be met at the time of completion of installation, the owner shall have a period of thirty (30) days to comply with the above requirements; provided, however, that during said thirty (30) day period, a battery operated carbon monoxide detector with an alarm shall be installed.
2. **APPROVED CARBON MONOXIDE DETECTORS** Each carbon monoxide detector as required in accordance with the above provisions shall comply with NFPA 720 and be ANSI/UL 2034 listed and IAS certified.
3. **SIGNAGE** A metal or plastic identification plate shall be permanently mounted to the exterior of the building at a minimum height of eight (8) feet above grade directly in line with the exhaust vent terminal for the horizontally vented gas fueled heating appliance or equipment. The sign shall read, in print size no less than one-half (1/2) inch in size, “GAS VENT DIRECTLY BELOW. KEEP CLEAR OF ALL OBSTRUCTIONS”.
4. **INSPECTION** The state or local gas inspector of the side wall horizontally vented gas fueled equipment shall not approve the installation unless, upon inspection, the inspector observes carbon monoxide detectors and signage installed in accordance with the provisions of 248 CMR 5.08(2)(a)1 through 4.
    a. **EXEMPTIONS** The following equipment is exempt from 248 CMR 5.08(2)(a)1 through 4:
        i. The equipment listed in Chapter 10 entitled “Equipment Not Required To Be Vented” in the most current edition of NFPA 54 as adopted by the Board; and
        ii. Product Approved side wall horizontally vented gas fueled equipment installed in a room or structure separate from the dwelling, building or structure used in whole or in part for residential purposes.

Special Installation Requirements, cont.

9.2 - Installation at High Altitudes

This appliance is equipped with an automatic combustion characteristic adjustment system, provided the installed elevation above sea level is entered into the operating control when the elevation is greater than 2,000 feet and less than or equal to 9,000 feet.

For elevations above 9,000 feet, set the maximum altitude allowable and set combustion as normal.

These appliance's have been operating at elevations up to 16,500 feet above sea level on LP gas; for more than 15 years utilizing these settings and a special burner and burner door that must be factory installed and tested during production.

To enter the operating elevation:

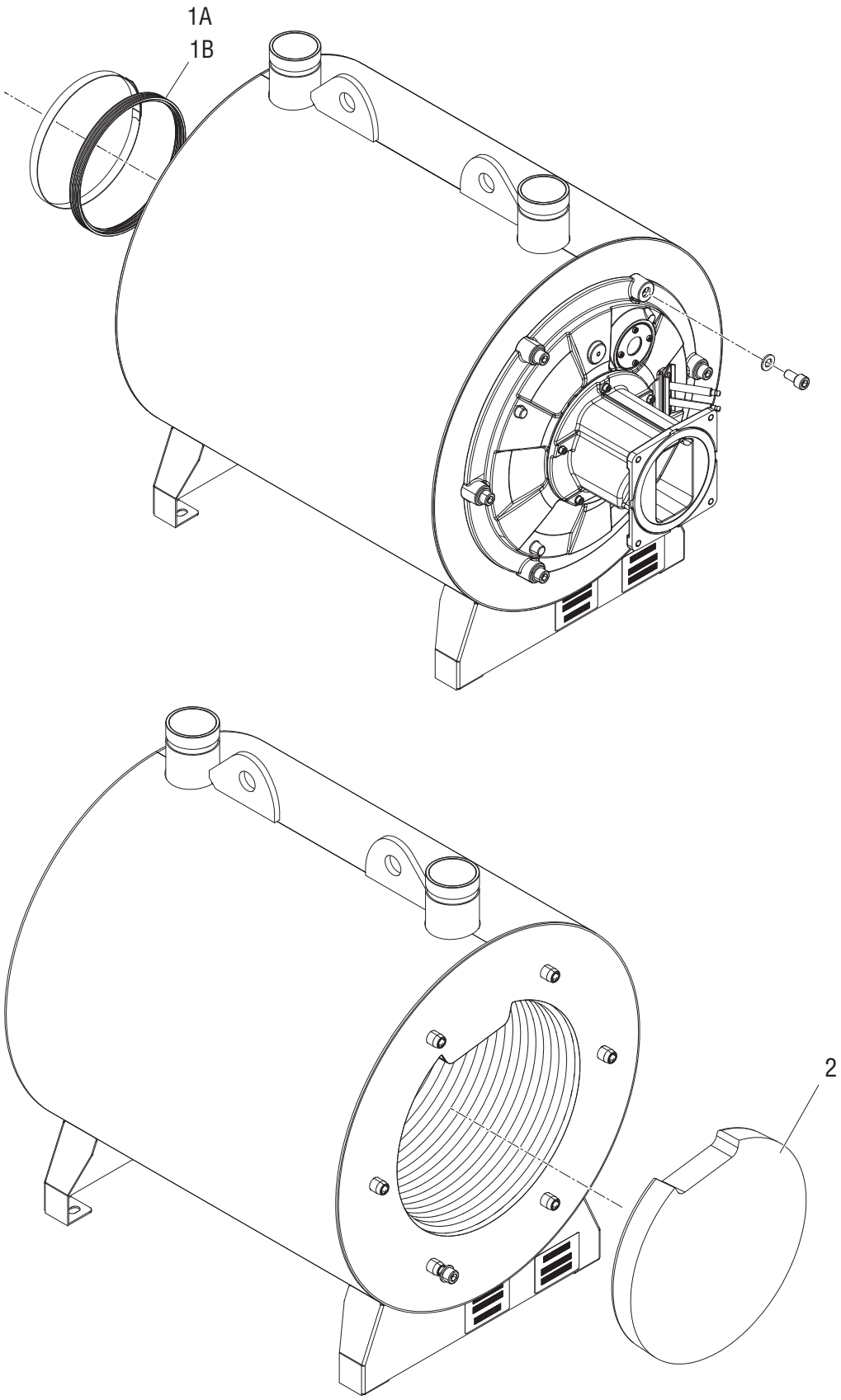
- From the setup menu, enter the password for the installer level or higher. Enter the parameters menu, then the altitude parameter set. Enter the appropriate elevation for the installation.
- The adjusted altitude entered is internally converted to an offset on top of the maximum fan speed.

By adjusting the combustion characteristics as described above, there is no de-rate required at altitudes up to 9,000 feet. For elevations in excess of 9,000 feet or gas BTU content levels below 950 BTU/cubic foot, consult the factory at 800.968.5530 for adjustments and de-rating information.

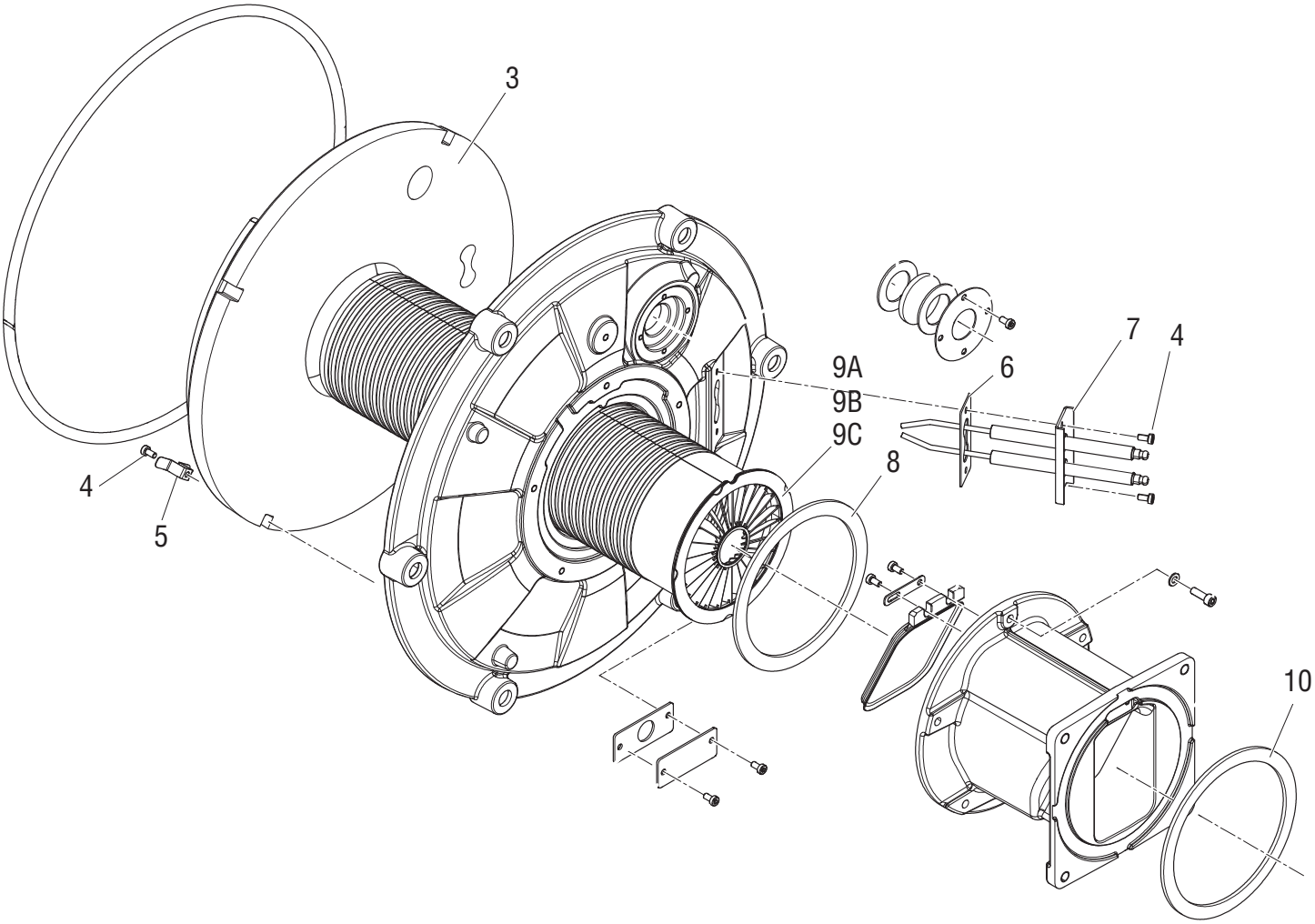
Max △P

Model	Air Pressure (△P)
HW 800	0.68" wc
HW 1000	0.88" wc
HW 1500	1.64" wc

10.0 - Parts Breakdown



Parts Breakdown, cont.

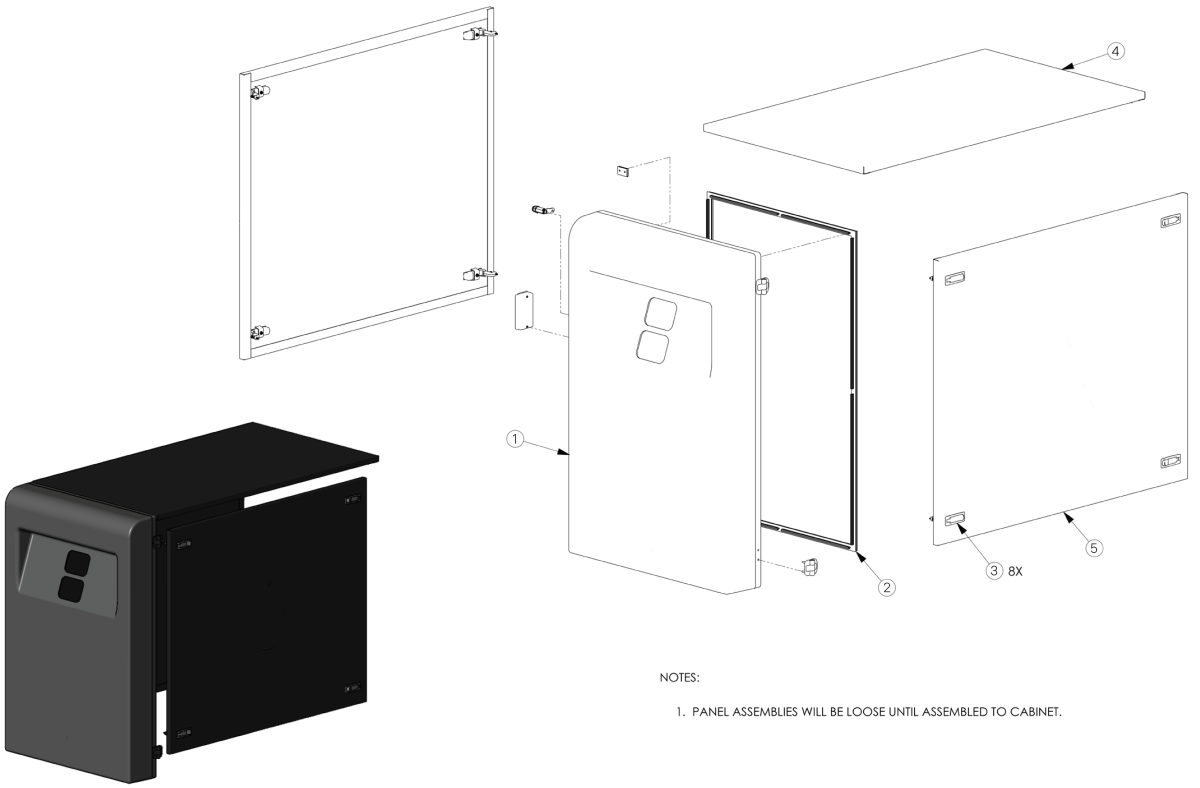


Parts Breakdown, cont.

10.1 - Heat Exchanger Spare Parts

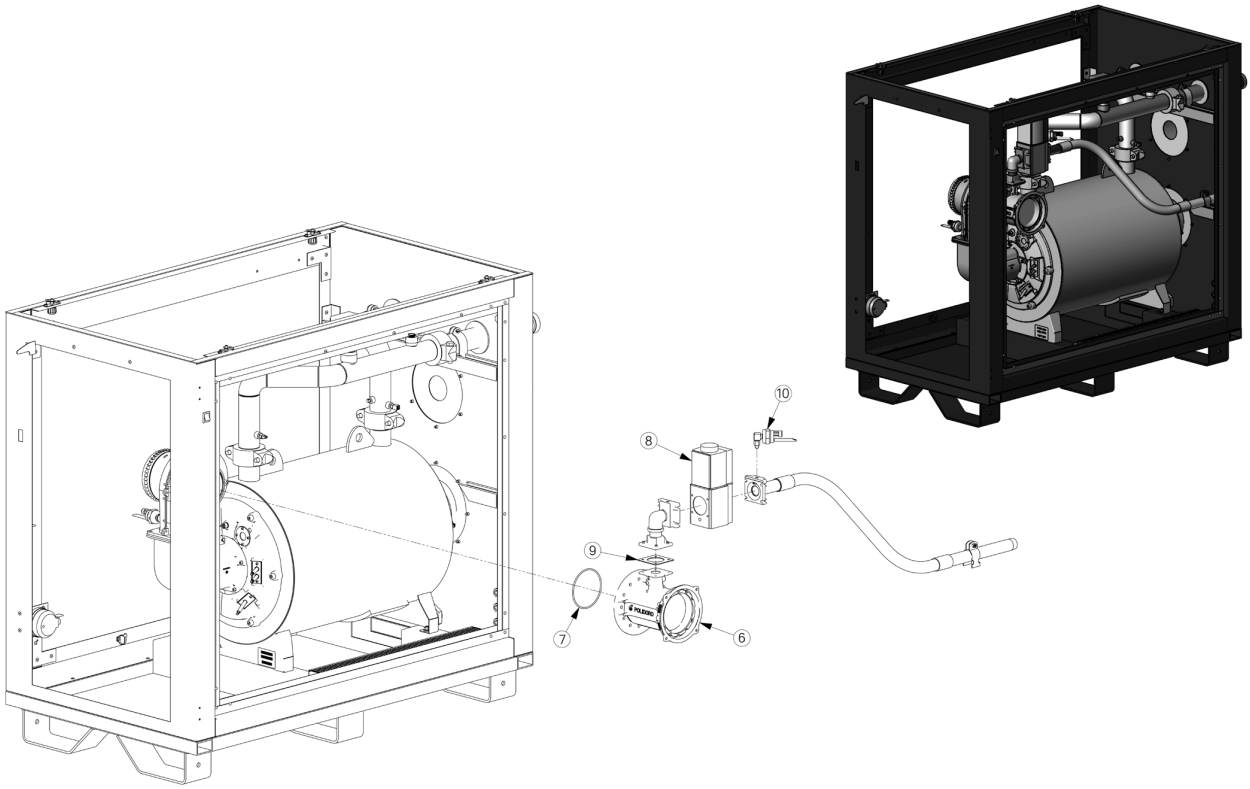
ITEM	PART NUMBER	DESCRIPTION	QUANTITY PER HX
1A	D146956	8" Flue Exit Gasket (1.5M)	1
1B	D146957	6" Flue Exit Gasket (800K & 1M)	1
2	D146958	Heat Exchanger Insulation (800K, 1M, 1.5M)	1
3	D146959	Burner Door Insulation (800K, 1M, 1.5M)	1
4	D146960	Screw (M4x8)	14
5	D146961	Buner Door Insulation Clip	4
6	D146962	Ignition Electrode Gasket	1
7	D146963	LNHEXT Ignition Electrode	1
8	D146964	Burner Gasket (800K, 1M, 1.5M)	1
9A	D146965	Bluejet Burner (800K)	1
9B	D146966	Bluejet Burner (1M)	1
9C	D146967	Mesh Burner (1.5M)	1
10	D146968	Intake Manifold Gasket (800K, 1M, 1.5M)	1
	D133303	800K Complete HX 'H'	
	D153055	800K Complete HX 'H'	
	D133304	1000M Complete HX 'H'	
	D153056	1000M Complete HX 'HLW'	
	D133305	1500M Complete Hx 'H'	
	D153057	1500M Complete HX 'HLW'	

Parts Breakdown, cont.

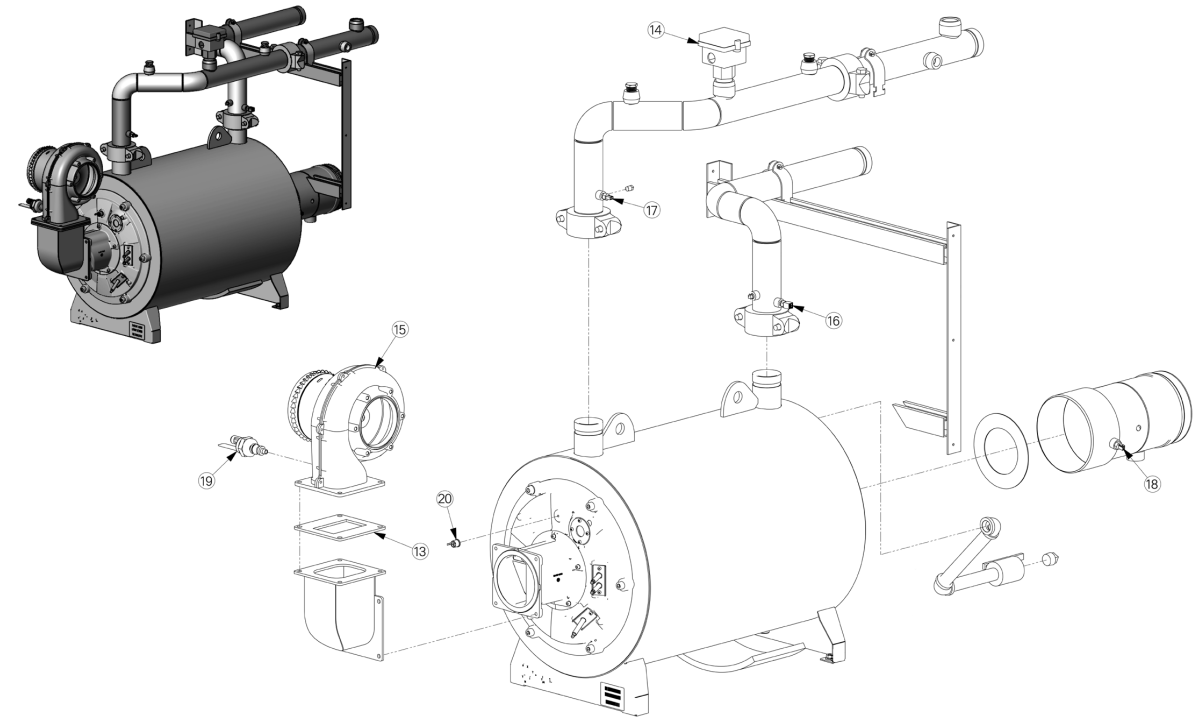


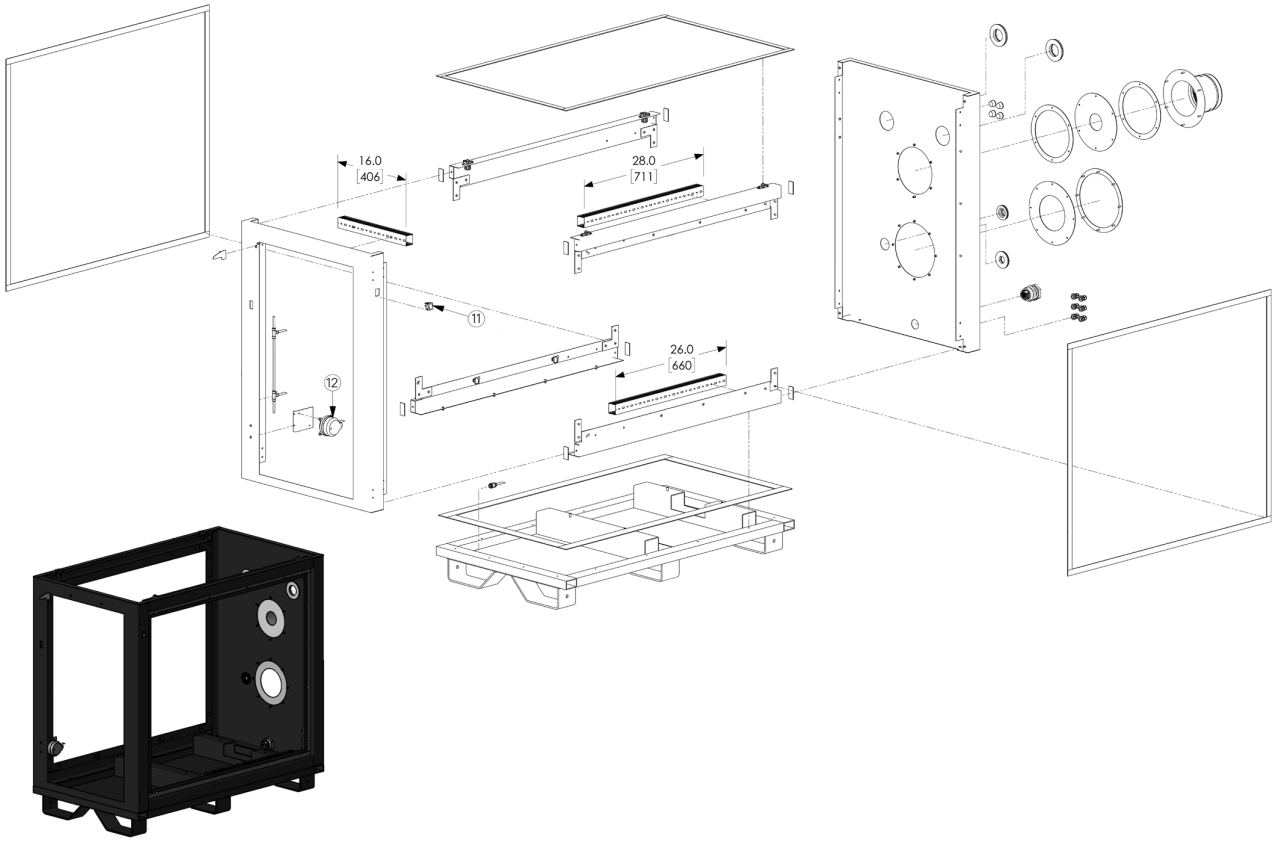
NOTES:

1. PANEL ASSEMBLIES WILL BE LOOSE UNTIL ASSEMBLED TO CABINET.



Parts Breakdown, cont.





Parts Breakdown, cont.

BALLOON ID	PART NUMBER	PART DESCRIPTION	QTY PER ASSEMBLY
1	D133858	ASCEND FRONT DOOR	1
2	D133882	MAG DOOR GASKET	1
3	D133693	SIDE PANEL LATCH	8
4	D133331	PANEL TOP 1000/1500	1
	D133330	PANEL TOP 800	1
5	D133336	PANEL SIDE 1000/1500	2
	D133335	PANEL SIDE 800	2
6	D152597	MIXER AIR/GAS 800NG/LP	1
	D152598	MIXER AIR/GAS 1000NG	1
	D152599	MIXER AIR/GAS 1000LP	1
	D152600	MIXER AIR/GAS 1500NG	1
	D152601	MIXER AIR/GAS 1500LP	1
7	D161676	O-RING RD 110MM X 3.5MM EPDM 70A DURO	1
8	D195574	GAS VALVE	1
9	D133642	GASKET SQ 75MM EPDM 60 W/ 48MM HOLE	1
10	D104962	TRANSDUCER PRESS 1/4 MNPT +/-1 PSI	1
11	D108302	SWITCH RKR ON/OFF 20A 250V DPST	1
12	D113636	SWITCH DIF PRESS M20 CONN CNDS HW79-599	1
13	D195578	GASKET FAN OUT	1
14	D195579	FLOW SWITCH	1
15	D134974	FAN BLOWER	1
16	D104920	THERMISTOR 1/8 NPT X 25 MM 10 KOHM NEGATIVE TEMP COEFFICIENT DUPLEX	1
17	D104919	THERMISTOR 1/8 NPT X 25 MM 10 KOHM NEGATIVE TEMP COEFFICIENT	1
18	D104921	THERMISTOR 1/4 MBSPP X 55 MM 10 KOHM NEGATIVE TEMP COEFFICIENT	1
19	D104963	TRANSDUCER PRESS 1/4 MNPT 0-1/2 PSI	1
20	D106936	SWITCH TEMP LIMIT BURNER DOOR	1

11.0 - DRV General Information

11.1 - Introduction

The Brain® DRV is a registered trademark of Armstrong Hot Water Group, a division of Armstrong International.

The Brain® features Rada Technology, Rada is a registered trademark of Kohler Mira Limited of Cheltenham, England.

The Brain® is a digital recirculating type 1 controller valve for use as part of a warm water recirculation system within a commercial installation.

A dedicated accompanying mobile app can monitor and control temperature limits, disinfection cycle and view error logs. This product can be linked to external control and monitoring devices such as a Building Management System. Data connections can be made via the dedicated BMS port.

Download the “SAGE® by Armstrong” mobile app from either the Apple App Store or Google Play or scan the QR code.

11.2 - Safety

Icon Legend

If instructions are not followed:

Injury or death and property damage are imminent

Injury or death and property damage are possible

Potential property damage, expensive repairs, and / or voiding the warranty may result

- Applicable codes must be followed and supersede any other instructions. Generally applicable codes in the US include:
- IPC (International Plumbing Code)
- Read this manual
- Improper installation or operation may cause a flood resulting in property damage, personal injury, or death. Armstrong strongly recommends that a qualified installer be used.
- Service must be performed by a qualified person.
- Improper installation, start-up, operation, maintenance, or service may void the warranty.
- Hot water or metal may cause scald burns. Skin exposure to 140°F water or metal for only five seconds may cause a second degree burn.

DRV General Information, cont.

11.3 - General Advisory

The use of the word ‘failsafe’ to describe the function of any hot and cold water mixing valve is both incorrect and misleading. This DRV (Digital Recirculation Valve) incorporates additional shut-off devices to improve the level of safety however, in keeping with every other mechanism it cannot be considered as being functionally infallible.

Where chloramine / chlorine disinfection is practiced, DO NOT exceed a chloramine / chlorine concentration of 50 mg/l (ppm) in water, per one hour dwell time. Such procedures must be conducted strictly in accordance with the information supplied with the disinfectant and with all relevant Guidelines / Approved Codes of Practice.

Water must have levels of chloramine / chlorine lower than or equal to 4mg/l (ppm) for continual usage.

11.3.1 - Data Storage

Armstrong International shall not accept liability in contract, tort (including negligence or otherwise) for any loss of profits, business or anticipated savings, or loss or corruption of data, or any indirect or consequential loss arising out of the customer's use of DRV25. The customer shall be solely responsible for the independent backup of all data / information stored on DRV25. Notwithstanding the foregoing, none of the exclusions and limitations stated above are intended to limit any rights the customer may have under local law or other statutory rights which may not be excluded.

11.3.2 - Patents

GB - 2 421 297 2 437 891

US - 7669776 8043556

PCT - PCT/GB2006/000159

European - 06702758.1

India - 1231/MUMNP/2007

Australia - 2006207367

Canada - 2595064

China - ZL200680005853.8

Japan - 4933451

11.3.3 - Recycling and Disposal

This product and batteries should not be disposed of with your general household waste. When this product or batteries have reached the end of their serviceable life, take the product or batteries to a recognized WEEE (Waste Electrical and Electronic Equipment) collection facility such as your local civic amenity site for recycling. Your local authority or retailer can direct you to the nearest recycling facility.

11.4 - Standards and Codes

11.4.1 - FCC Compliance Notice

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

Note! This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help

Any modifications made to this device that are not approved by Rada may void the authority granted to the user by the FCC to operate this equipment.

11.4.2 - Industry Canada

CAN ICES-3 (B) / NMB-3(B)

The Bluetooth® word mark and logos are registered trademarks owned by the Bluetooth SIG, Inc. and any use of such marks by Kohler Mira Ltd is under license. Other trademarks and trade names are those of their respective owners.

12.0 - DRV Specifications

12.0 - DRV25 and DRV40 Specifications

DRV25-specific specifications apply to ASCEND® 800 and DRV40-specific specifications apply to ASCEND® 1000 and 1500.

General		
Protection	NEMA 3S	
Ambient Temperature	Minimum ambient temperature of 35 °F (2 °C) maximum 122 °F (50 °C)	
Ambient Humidity	95% Non-condensing	
Connections	DRV25: 1” NPT Internal (female)	DRV40: 1-1/2” NPT internal (female)
Installation Environment	Suitable for indoor use only	
Normal Environmental Conditions	Altitude up to 2000m	
IP Rating	IPx3	
Materials	Electronics Casing: PC/ABS Valve: Stainless Steel, engineering plastics and elastomers Motor: Electronic microstepper motor	
Safety	Thermal shutdown upon inlet supply failure and / or power failure	
Weight	DRV25: 6.83 lbs (3.1 kg)	DRV40: 11.5 lbs (5.2 kg)
Pressures		
Maximum Inlet Supply Pressure	200psi (1379 kPa = 13.8 bar)	
Minimum Inlet Supply Pressure	20 psi (138 kPa = 1.5 bar)	
Supply Pressure Differential	Inlet supply pressures must be nominally equal	
Temperature		
Maximum Inlet Hot Water Supply	185°F (131°F (55°C) max. for on/off dead leg group fixture control)	
Minimum Inlet Hot Water Supply	DRV25: 2°F (1°C) above set point	DRV40: 5°F (2°C) above set point
Minimum Inlet Cold Water	35.6°F (2°C)	
Set Point Range	81°F to 185°F (27°C to 70°C)	
Minimum Recirculation Loop Temperature Loss	1°F (≤1°C)	
Recirculation Circuit		
Minimum distance to First Outlet	25 ft (7.6 m)	
Flow Rates		
Maximum Suggested Flow Rate	DRV 25: 45 gpm (170 lpm)	DRV40: 98 gpm (371 lpm)
Minimum Recirculation Flow Rate	DRV25: 2 gpm (8 lpm)	DRV40: 5 gpm (19 lpm)
Minimum System Draw-off	0 gpm (0 lpm) during recirculation, 2 gpm (8 lpm) during group control	
Electrical		
Power Supply	120 - 240V AC ~ 50/60Hz, 1.25A, 15W	
Supply Fuse / Circuit Breaker	Grounding is required. Switched type 3 Amp (no plug), 15 Amp Grounding-type receptacle (plug).	
Battery	DRV25: Qty (4) Duracell High Power Lithium CR2 (3V)	DRV40: Qty (2) CR - P2 6V
Duty Cycle	Continuously rated	
Overvoltage	Category II	
Classification	Pollution Degree 2	
Rated Impulse Voltage	4KV AC	

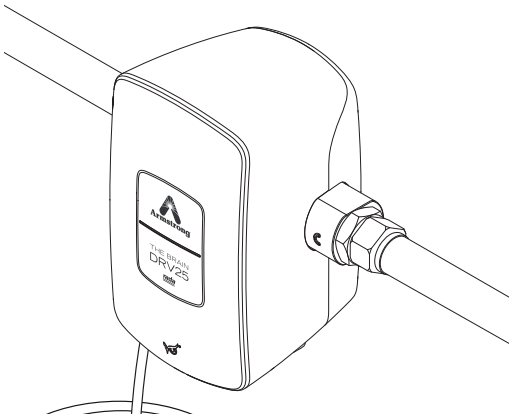
13.0 - DRV Commissioning

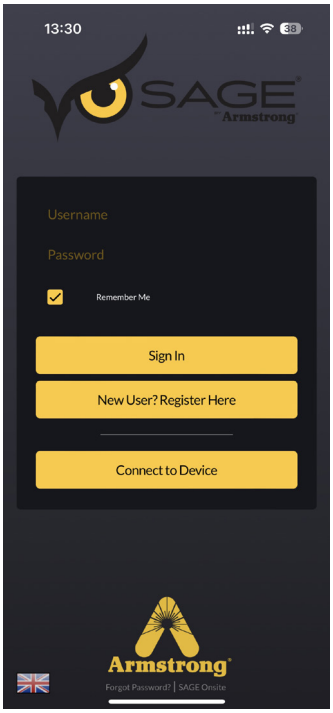
13.1 - Commissioning

Commissioning must be carried out in accordance with these instructions by designated, qualified and competent personnel.

NOTE: References in this section made to DRV25 will also apply to DRV40 valves.

1. Ensure the system is powered off and the power cable is unplugged from the primary power supply.
2. Flood the system in the following sequence:
   - Open the cold water supply isolation valve(s).
   - Open the outlet flow isolation valve(s).
   - Open the hot water supply isolation valve(s).
   - Once flooded, connect the power cable to the primary power supply via switched circuit breaker with a 3 Amp fuse or a 15 Amp grounding-type receptacle (socket).
3. Ensure that the DRV25 is powered and the LED on the front cover is illuminated.
4. The LED indicator initially flashes red, green and blue upon power up then changes to green once operational.
5. Make sure the hot and cold inlet supplies are at their designated pressures and temperatures.
6. Close all the mixed water outlets and turn on the circulating pump.
7. Open SAGE® mobile app on your mobile device and tap on the 'Connect to Device' to pair with the DRV25.
8. Note! Ensure Bluetooth is enabled on your device.
9. Note! The "SAGE® by Armstrong" mobile app is available free to download from the Apple App Store and Google Play Store.





Download on the App Store

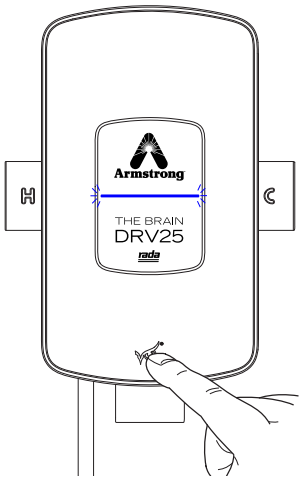
GET IT ON Google Play

DRV Commissioning, cont.

10. Tap on the ‘Pair New Device’ to search available devices using Bluetooth.

11. Select ‘Armstrong DRV25’ on the screen.

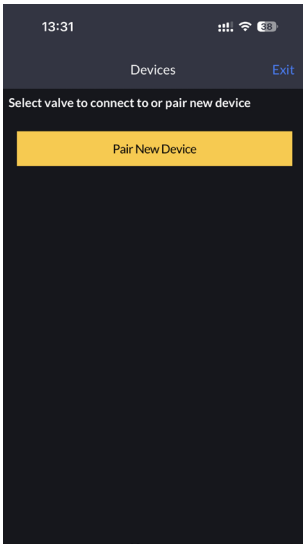
12. Make sure your mobile device is within Bluetooth range and the DRV25 and Bluetooth is enabled. Press and hold the SAGE® Owl logo located at the bottom of the front cover until you see the blue light flash. Then tap ‘Proceed’. At the next screen tap the corresponding DRV25 you wish to pair to.

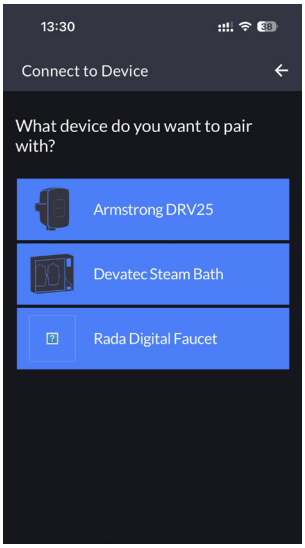


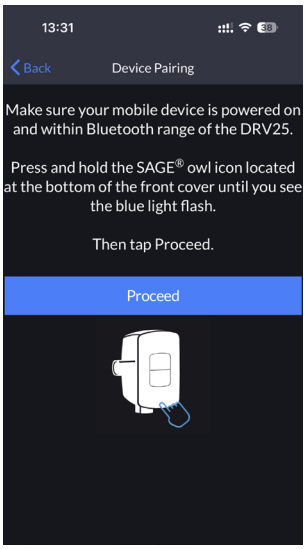
13. Once paired, tap on the ‘Setpoints’ icon to change the default setpoint if required. The setpoint was preprogrammed at the factory according to the installation details specified on the Installation Detail Form (IDF).

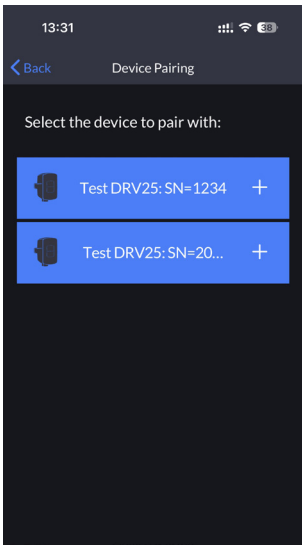
14. Amend the other default settings as required and tap on ‘Save’ to update new settings.

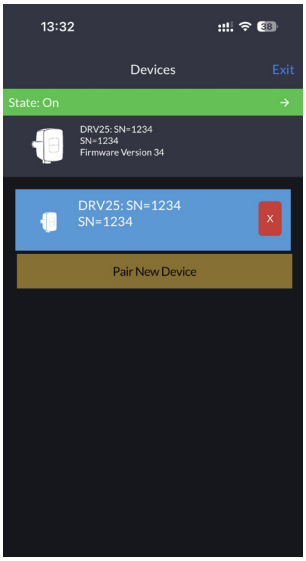
15. Upon connection to the mobile app, the internal real time clock will be re-synchronised to the mobile device and will also occur upon each re-connection. Periodically connect to the DRV25 to re-synchronise the date and time, especially post-daylight savings dates for your installation location.

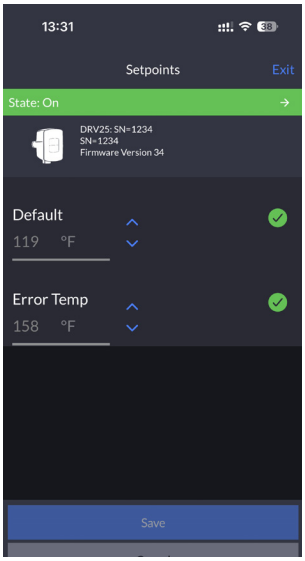






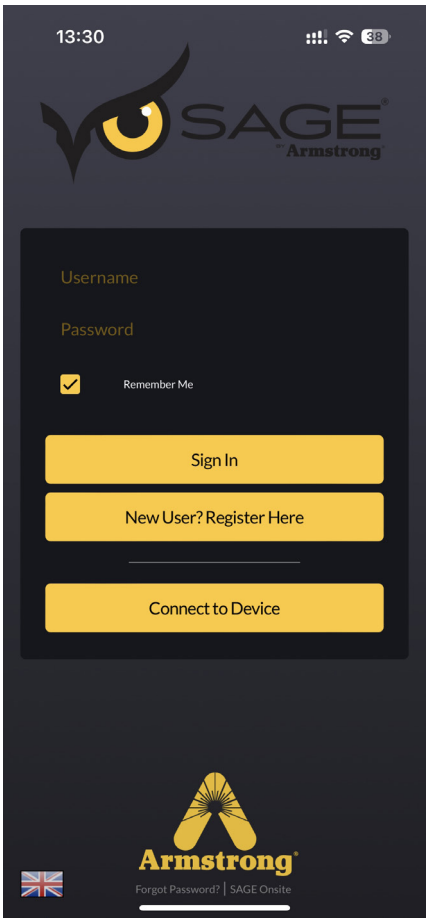


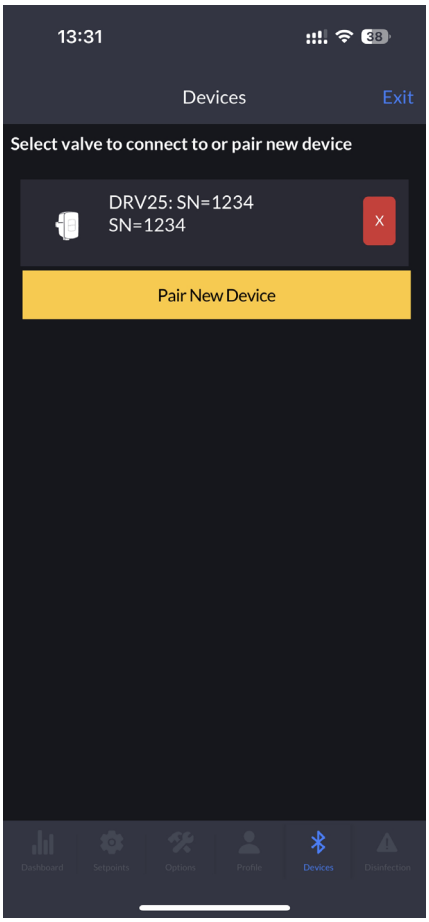




14.0 - DRV Mobile App

14.1 - Connect to the DRV





Make sure your mobile device is within Bluetooth range and that Bluetooth is enabled. Identify the DRV on the SAGE® mobile app to connect to and tap the corresponding product.

DRV Mobile App, cont.

14.2 - Dashboard

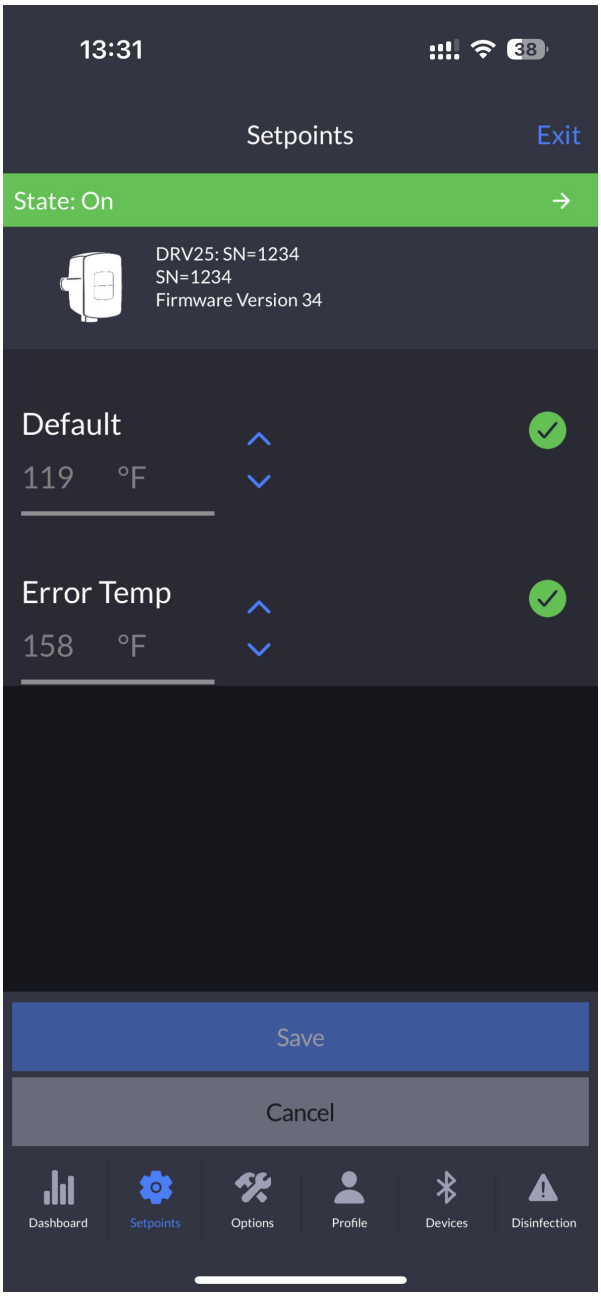
Once connected to the mobile device, the control screens can be selected individually by tapping on each of the tabs at the bottom of the screen.

The general status of the DRV is displayed by default upon connection.

The mixed water (outlet) temperature as well as the hot water supply inlet and system return inlet temperatures are displayed and refreshed every few seconds. The DRV setpoint is also displayed for reference.

DRV Mobile App, cont.

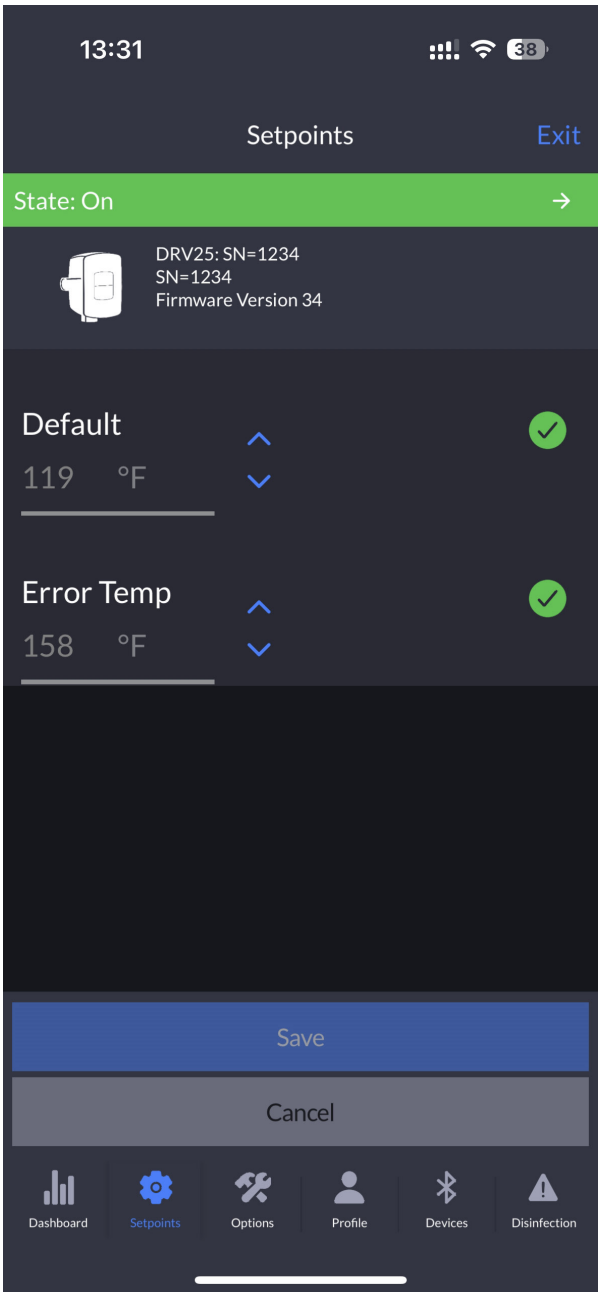
14.3 - Configure Set Points



1. Adjust the **Default Blend Temperature** Setpoint by tapping on the Up or Down arrow to configure the desired outlet temperature of the DRV25.
2. Adjust the **Error Temperature** setting as required. This temperature setting will be the point at which the DRV alarms and reverts to recirculation mode due to an over temperature condition.
3. Tap on the **Save** button to transfer the new settings to the DRV.

DRV Mobile App, cont.

14.4 - Options



Valve State - Allows the user to manually switch between the Blend Mode (ON) and the Recirculation Mode (OFF).

Protocol - Switches the protocol standard on the wired connector port CN7 (see **Page 89** for more details).

Baud Rate - Allows the protocol baud rate to be adjusted (options depend on selected protocol).

Disinfection Setpoint - This is the temperature at which the thermal disinfection will be carried out (must not exceed 185 °F / 85 °C).

Disinfection Timeout - This is the number of minutes the error alarm is disabled to allow for disinfection and cool down of the blend circuit before switching back on automatically, i.e. if Disinfection Timeout is set to 100 minutes then the DRV has that time to complete the disinfection and cool down before entering an over temperature error condition and switching to full cold.

Please note the following:

- Disinfection Timeout starts when the disinfection cycle is triggered. (Refer to the “Thermal Disinfection” section on **Pages 83 - 88** for more details)
- During the Disinfection Timeout, the disinfection and cool down must be completed manually and the DRV25 returned to Setpoint (normal operation within the setpoint limits).
- The Disinfection Timeout can be set up to a maximum of 1800 minutes (30 hours).

Address - This is the network address of the DRV for the selected protocol.

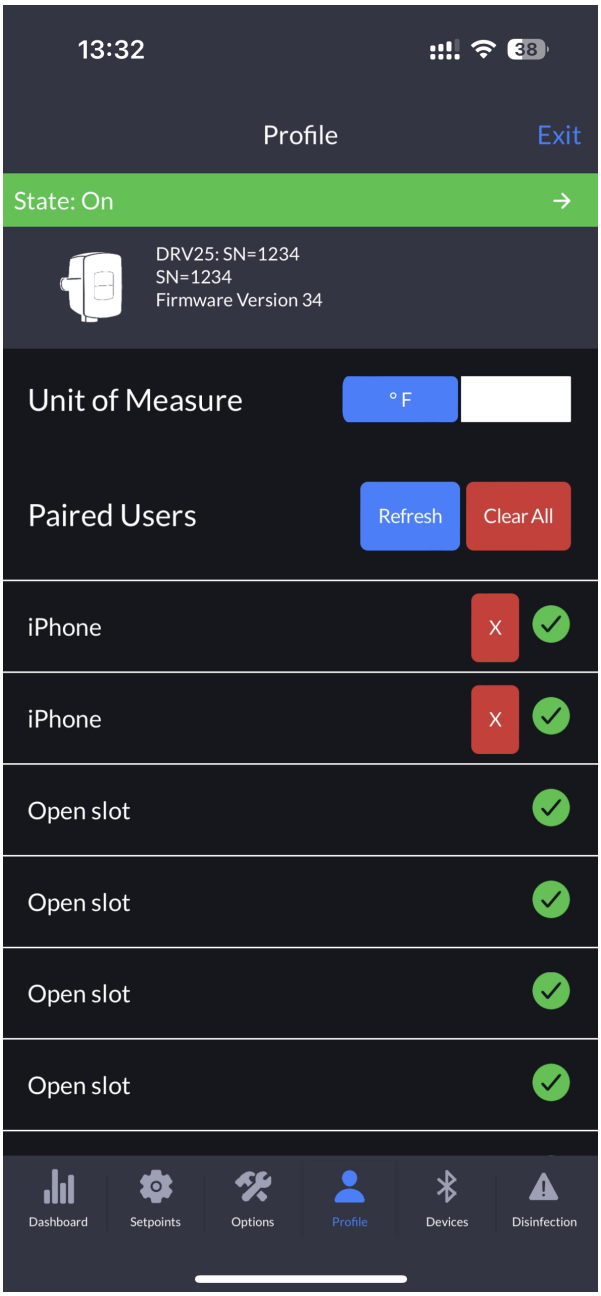
ID - Update the device ID, alias as required to give the DRV a more meaningful name. e.g. Bayfront Loop 1

Disinfection Enabled - This is the master disinfection enable switch. It must be set to the ON position before disinfection can be carried out.

Reboot - Forces the DRV to reboot. This will potentially deliver full hot water whilst this is carried out. This function can be used to clear some error conditions.

DRV Mobile App, cont.

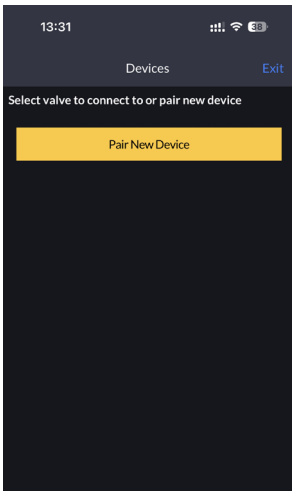
14.5 - Profile Settings

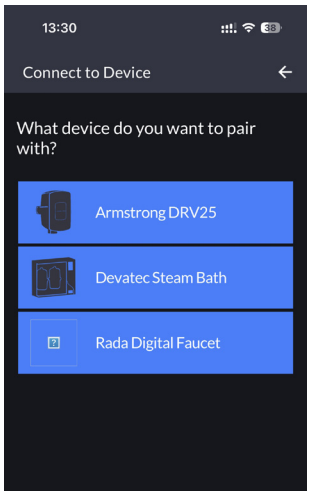


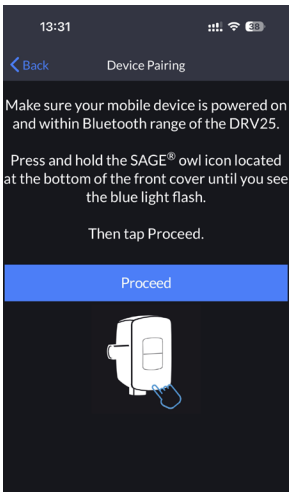
1. The Units of temperature measurement can be changed to °F / °C as required.
2. Paired users to the DRV can be managed as required.

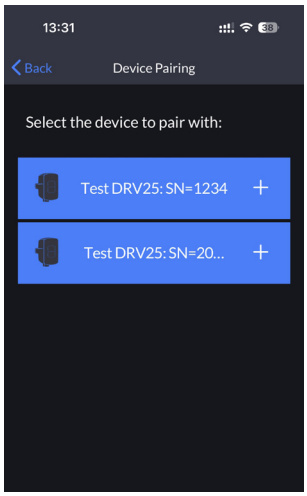
DRV Mobile App, cont.

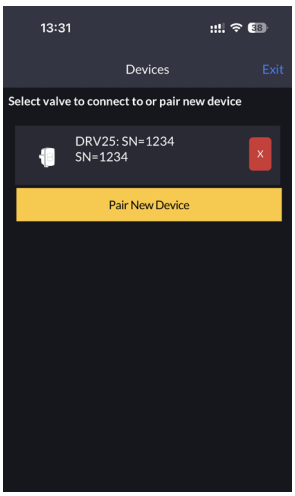
14.6 - Devices











1. Additional DRV25 products can be connected to your mobile device if required. See **Page 75** for more details.

   Note! Any currently connected DRV product must be disconnected prior to pairing to a new device.

2. Tap on the red ‘X’ to disconnect the current DRV connection. A subsequent tap will delete the DRV pairing from the mobile app.

15.0 - Thermal Disinfection

15.1 - Thermal Disinfection Information

IMPORTANT! PLEASE READ CAREFULLY!

The thermal disinfection mode of the DRV is not an automated process. It is manually activated by the supervisor to increase the temperature of the blend circuit to equal the temperature of the hot supply. The circuit pipework and outlets can be thermally disinfected as part of a bacterial infection control regimen.

DO NOT USE THE THERMAL DISINFECTION FEATURE IF THE HOT WATER SUPPLY CAN EXCEED 185°F (85°C)! THE MAXIMUM TEMPERATURE FOR DISINFECTION SETPOINT MUST BE 185°F (85°C).

Warning! Thermal disinfection is a potentially hazardous process to raise the water temperature to a level that will scald or even kill. It is therefore the responsibility of the person supervising the process to make sure it is carried out correctly and safely.

ALL DRV ALERTS AND ERRORS ARE DISABLED DURING THE PROCESS!

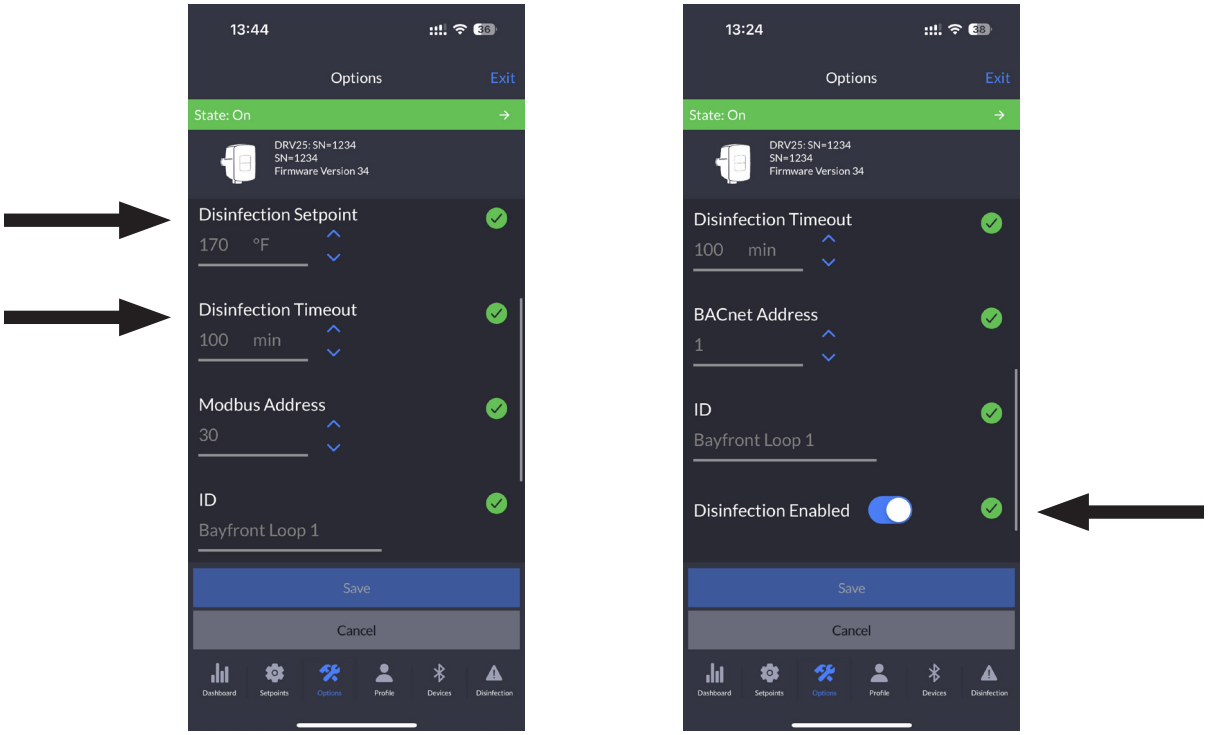
It is the responsibility of the supervisor to make sure that:

1. An appropriate Risk Assessment is carried out in accordance with the local or national regulations.
2. The water temperature is raised to and held at the required level at all parts of the circuit for the required duration as stated in the Risk Assessment.
3. All outlets are flushed for the correct amount of time if required by the Risk Assessment.
4. Appropriate measures are taken to make sure that none of the outlets are used while the water is at an unsafe temperature.
5. Once thermal disinfection is complete, the supervisor should return the DRV to its normal operating mode using the **Cool Down** button within the **Disinfection** screen. This will switch the DRV to its full cold position and allow the blend circuit to be reduced gradually to a safe temperature level*. Make sure the blend circuit temperature returns to normal operation within the **Disinfection Timeout** period (see **Page 80**).
6. The **Disinfection** cycle is monitored constantly and the supervisor is able to stop the cycle using the **Abort** button in the **Disinfection** screen.
7. In the event of the user failing to enter cool down mode within the **Disinfection Timeout** period, the DRV will automatically enter the cool down phase for 5 minutes.

*Without a draw off, the water in the blend circuit will remain hot for a long time. In order to speed up the temperature reduction, a draw-off must be made during Cool Down using the last outlet of the blend circuit, or a dump valve fitted near to the end of the blend circuit. Check with local water authorities with regard to water temperature limitations to drain.

Failure to complete a sufficient cool down of the blend circuit may result an Error Temp shut down to full cold.

Thermal Disinfection, cont.



Disinfection Setpoint and Timeout: Verify and confirm the **Disinfection Setpoints** and **Timeout** are set correctly in the Options tab prior to starting the disinfection cycle (see **Page 80** for more details). Tap on the **Disinfection** tab to proceed

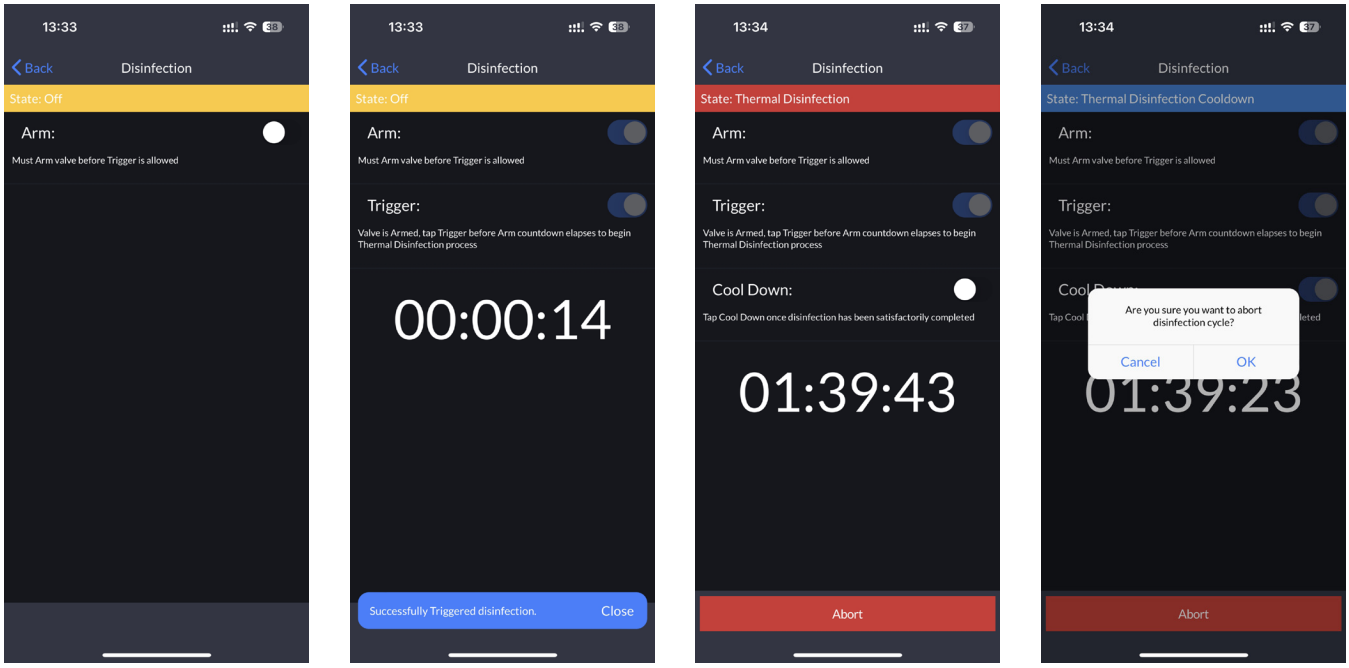
Disinfection Timeout Note: The timeout is the number of minutes the temperature alert and error alarms are disabled to allow for disinfection and cool down of the blend circuit before switching back on automatically, i.e. if **Disinfection Timeout** is set to 100 minutes then the DRV has that time to complete the disinfection and cool down before entering an error condition and switching to full cold (recirculation).

Please note the following:

- **Disinfection Timeout** starts when Trigger is tapped.
- During the **Disinfection Timeout** the disinfection and cool down must be completed manually and the DRV returned to **Setpoint** (normal operation within the setpoint limits).
- The **Disinfection Timeout** can be set up to a maximum of 1800 minutes (30 hours).
- In the event of failing to cool the DRV, an automatic cool down period of 5 minutes will take effect.

Thermal Disinfection, cont.

15.2 - Thermal Disinfection Procedure



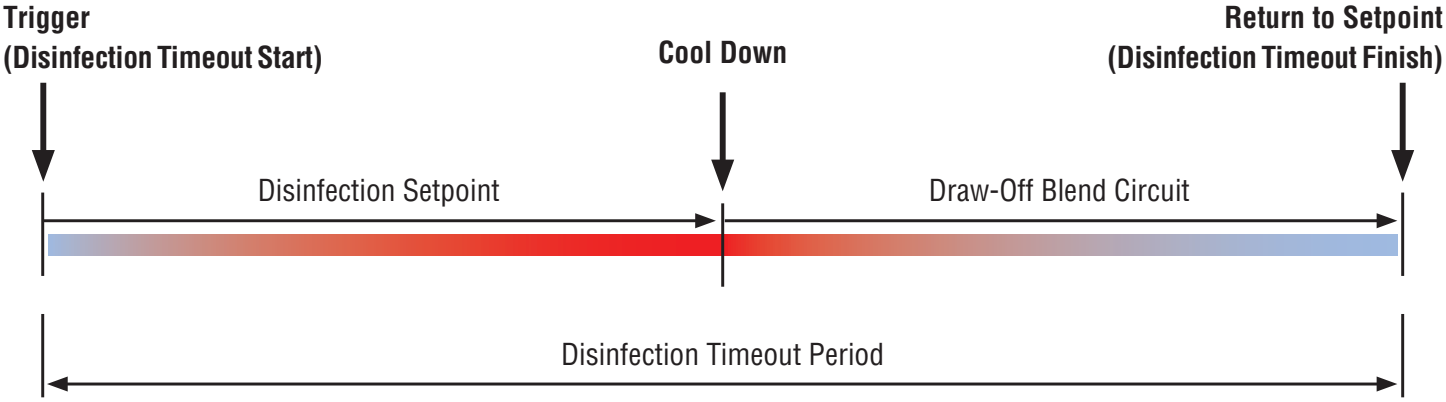
1. Close all outlets in the system.
2. Toggle Arm and Trigger to ON position NOTE: Trigger will be available to toggle within 10 seconds of arming to activate the disinfection.
3. Disinfection cycle will then commence after a 10 seconds delay. The LED on the front cover will flash red.
4. Toggle Cool Down to ON position once disinfection has been satisfactorily completed.
5. Ensure each outlet is flushed of high temperature water and the system has returned to safe temperature prior to opening for use. At the end of the Disinfection Timeout period, the DRV25 will return to normal operating mode and the alerts and errors will be re-enabled.
6. EMERGENCY STOP! - Tap Abort* at any time to stop the cycle.

Thermal Disinfection, cont.

IMPORTANT! The DRV is locked in disinfection mode until one of the following actions has been performed:

1. The Disinfection Timeout period has expired (automatic).
2. The Abort button is pressed (manual).

15.3 - Disinfection Timeline



***Abort - If Abort is used when the cycle is disinfecting, the DRV25 switches to full cold / recirculation. Use the mobile app to change the valve state back to ON and make sure the blend circuit is at a safe temperature before allowing any outlets to be used.**

Thermal Disinfection, cont.

15.4 - Disinfection Quick Start Guide - 1 (Setting Parameters for Cycles)

Follow these steps to determine the total disinfection cycle time and store that value in the Disinfection Timeout parameter of the SAGE® mobile app. At the end, the parameters will be set to run all future disinfection cycles reliably.

You are about to run a test cycle to determine, in total, how long it takes to disinfect the blend circuit. Before you begin, make sure there is an adequate supply of hot water for this test. You will also require a reliable clock or stopwatch to monitor the duration of the test. Make sure all warnings, cautions and responsibilities on **Page 83** are observed during the test.

1. Verify and confirm the Disinfection Setpoints and Timeout are set correctly in the Options tab.
2. Tap on the Disinfection tab to proceed.

MAKE SURE ALL OUTLETS ON BLEND CIRCUIT ARE NOT IN USE UNTIL TEST IS COMPLETE! No one should be allowed to approach within 10 feet (3 meters) of any affected outlets.

3. Toggle **Arm** to **ON** position.
4. Toggle **Trigger** to **ON** position and start the stopwatch or note the time of day.
5. Monitor the temperature and time until a satisfactory disinfection of the blend circuit has been achieved.
6. Toggle **Cool Down** to **ON** position once disinfection has been satisfactorily completed.
7. Draw-off hot water from the blend circuit. Use either the last outlet on the circuit or a dump valve fitted near to the end of the circuit.
8. When the DRV temperature is within normal operation, stop the draw-off.
9. Tap on **Abort & Confirm**.
10. Stop stopwatch or note the time of day. The time difference is the future **Disinfection Timeout** period.
11. Change **Disinfection Timeout** to new value.
12. Tap **Save**.

For all further disinfection cycles, follow procedures on the next page.

15.5 - Disinfection Quick Start Guide - 2 (Running a Routine Cycle)

Disinfection Quick Start Guide - 2 (running a routine cycle)

You are about to run a disinfection cycle of the blend circuit. Before you begin, make sure there is an adequate supply of hot water for the cycle. You will also require a reliable clock or stopwatch to monitor the duration of part of the cycle.

Make sure all warnings, cautions and responsibilities on **Page 83** are observed during the cycle.

MAKE SURE ALL OUTLETS ON BLEND CIRCUIT ARE NOT IN USE UNTIL TEST IS COMPLETE! No one should be allowed to approach within 10 feet (3 meters) of any affected outlets.

1. Tap on the Disinfection tab to proceed
2. Toggle Arm to ON position.
3. Toggle Trigger to ON position.
4. Start the stopwatch or make a note of the time of day. Monitor the temperature and time until a satisfactory disinfection of the blend circuit has been achieved.
5. Toggle Cool Down to ON position once disinfection has been satisfactorily completed.
6. Draw-off hot water from the blend circuit. Use either the last outlet on the circuit or a dump valve fitted near to the end of the circuit.
7. When the DRV temperature is within normal operation, stop the draw-off.
8. Allow the DRV to return to normal operation automatically.

IMPORTANT! - CHANGES TO THE PLUMBING SYSTEM. Any alteration to the plumbing system that may affect the blend circuit may, as a consequence, also affect the Disinfection Timeout period. Repeat all steps in Quick Start Guide -1 to maintain a reliable disinfection cycle for the system.

16.0 - Connectivity

16.1 - Connectivity to Building Automation Systems or SAGE®

The integral RS485 Serial Port can be used to connect to either **SAGE®** or directly to a **Building Automation Systems (BAS)** which operates on a **Modbus RTU** or **BACnet protocol**.

16.1.1 - SAGE®

SAGE® is an optionally selected control module from Armstrong which enables an interface with Building Automation Systems (BAS) which utilize Modbus, Bacnet™ or LonWorks™ protocols via the use of specific ProtoCessor cards. SAGE® BS also has an ethernet port and operates as a web server for remote network access.

SAGE® includes remote hot water supply, cold / recirculation water supply, blended water outlet temperature outputs and is supplied with a system graphic, memory card for data storage and web based software.

SAGE® includes terminals for additional installer supplied RTDs, pressure transducers and pulse type flow meters and this data can be forwarded via the SAGE BS® interface.

A separate SAGE® specific Installation, Operation and Maintenance (IOM) Guide is available upon request. Please consult factory.

16.1.2 - Modbus

DRV can be configured to communicate directly with a BAS which utilizes Modbus RTU. When configured for Modbus the DRV becomes a Remote Terminal Unit (RTU). When connected directly to a BAS using Modbus RTU, the DRV25 will be assigned a unique network address which is configurable through the SAGE® mobile app.

16.1.3 - BACnet

DRV can also be configured to communicate directly with a BAS which utilizes BACnet. When configured for BACnet, the DRV will be assigned a unique network address which can be reconfigured using a BACnet communications tool.

A separate BAS Programming specific Installation, Operation and Maintenance (IOM) Guide is available upon request. Please consult factory.

17.0 - System Performance

17.1 - System Performance

For effective DRV performance, the DRV must be able to experience a minimum flow and a minimum temperature differential between its inlet and outlet supplies when the system is in zero demand. Zero demand is defined as periods when there is no mixed water outlet usage on the system.

Pre-installation calculations should have already determined the system heat loss characteristics. For optimum performance the DRV requires a minimum of 2°F (1°C) differential between the setpoint (the outlet temperature) and the thermometer which is installed on the system return line.

When there is no system draw-off, the DRV25 reverts to a zero demand. The recirculation temperature is continuously monitored and adjusted appropriately by the DRV25. The circulating pump must operate continuously. The DRV25 requires a minimum flow of 2 gpm (8 lpm) and the DRV40 requires a minimum flow of 5 gpm (19 lpm). If more than one unit is piped in parallel, the minimum flow must be multiplied by the number of units. (Ex: Two DRV25 valves requires a minimum flow of 4 gpm / 16 lpm).

The circulating pump is only required to keep water gently moving around the system. The pump should be sized and selected to overcome the system resistance (feet of head) at the minimum specified flow rate while also accounting for system heat loss.

17.2 - System Safety Measures

System safety measures such as the installation of an aquastat linked to the circulating pump which shuts the pump off if the system exceeds a given temperature setpoint is not required. DRV25 can be programmed to automatically shut off the system hot water supply in the event of an overtemperature condition (may require a BrainScan/ SAGE® System where available).

18.0 - Preventative Maintenance and Fitting Spare Parts

WARNING! Isolate power to the DRV. Ensure that the circulating pump is not operating.

18.1 - General Information

DRV components should be inspected annually, or more frequently where acknowledged site conditions such as high mineral content water dictate. Each DRV has a serial number that is maintained on file with the technical department at Armstrong. For any installation, operation, maintenance or technical support details not covered in this guide, please call consult factory and provide the model and serial number.

18.1.1 - ESD Handling

Appropriate electrostatic wrist strap or similar preventative damage measures should be taken when handling the main control PCBA within the product.

18.1.2 - Batteries

Batteries are supplied to ensure the DRV switches to Full Cold in the event of a primary power supply failure, they should not be considered to be a backup power supply.

Battery life is variable depending upon usage. A battery error message appears in the SAGE® mobile app when they require replacing. Where primary power supply failure occurs regularly or the DRV is installed within a supply system where safety is critical, the batteries must be changed at least every 12 months as part of an annual maintenance routine. In noncritical systems or where battery usage is low, longer replacement cycles may be considered up to a maximum of 5 years.

NOTE: Care must be taken when removing / replacing the batteries to avoid accidental piercing to the CR2 cells and or damage to the DRV internal looms and connectors

18.2 - Inspection of Critical Components and / or Assemblies

18.2.1 - O-Rings / Seals

All ‘wetted’ O -Rings / Seals must be checked or replaced at least every 12 months as part of an annual maintenance routine. In systems where water quality conditions are poor, more frequent replacement may be required.

NOTE: Do not use silicone grease on internal seals. Refer to **Page 98** (DRV25) and **Page 110** (DRV40) for how to identify the internal seals.

18.2.2 - Strainers

All supply strainers must be thoroughly cleaned at least every 12 months as part of an annual maintenance routine. Cleaning includes physically taking the strainer screen / basket out of the body and cleaning as well as flushing water through the body. In systems where water quality conditions are poor, more frequent cleaning may be required.

18.2.3 - Thermistors

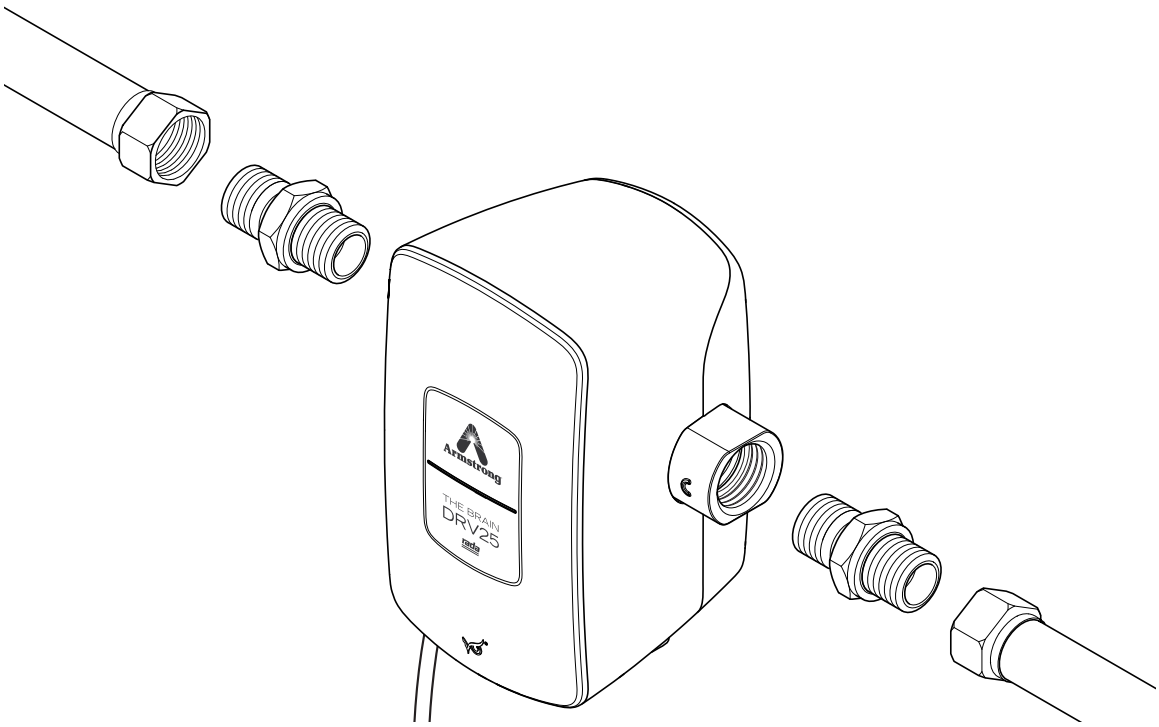
Remove thermistor loom and clean thermistors with an abrasive pad to remove surface contamination which could affect temperature readings and product performance.

DRV Spare Parts, cont.

18.3 - DRV25 Covers and Drive Mechanism Assembly

WARNING! Before disassembly, observe the following:

- **Isolate the electrical supply to the DRV25.**
- **Isolate the water supplies to the DRV25.**
- **Allow the hot water inlet to cool sufficiently to reduce the risk of injury through contact with the hot pipe or DRV.**



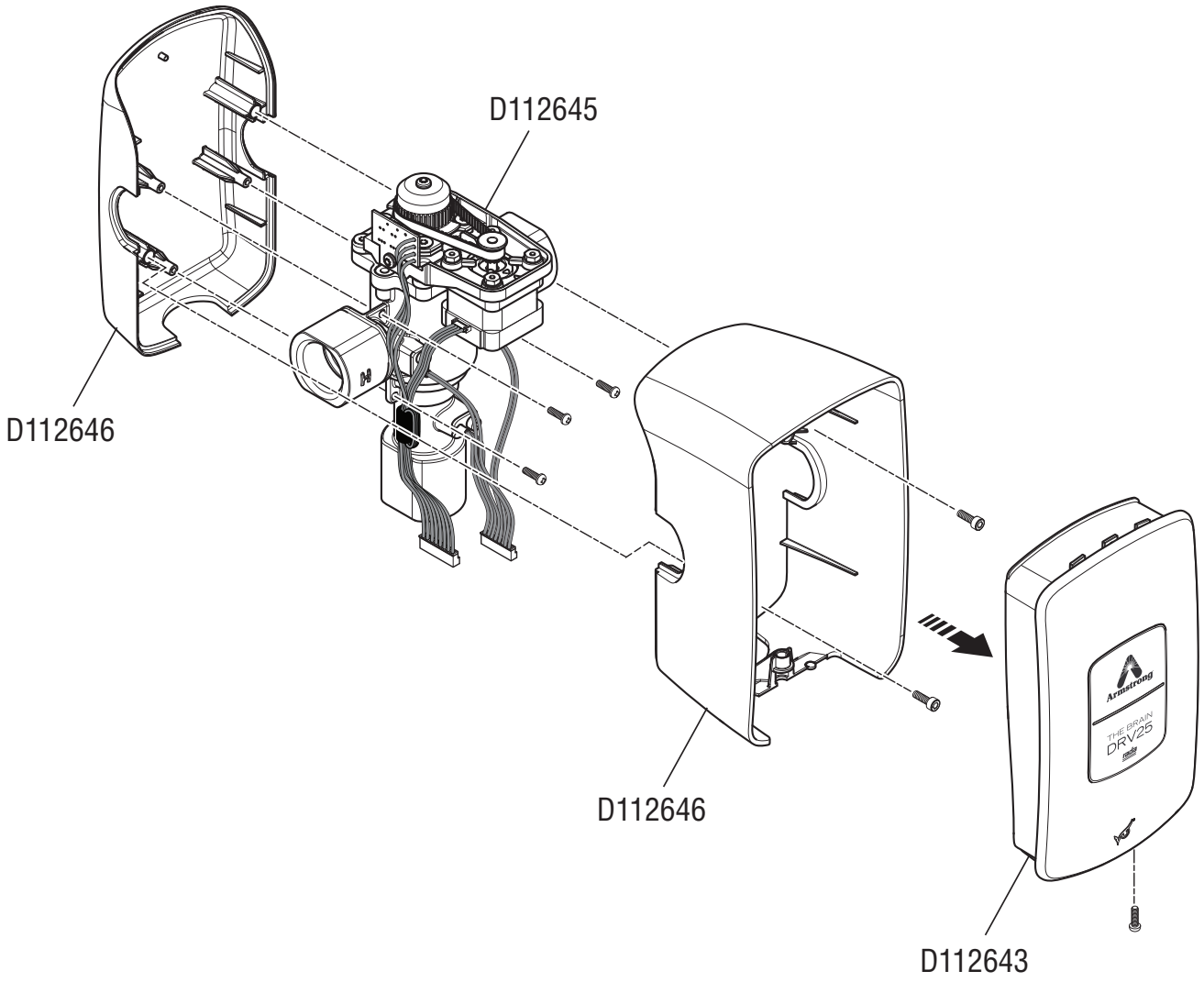
DRV Spare Parts, cont.

D112643 Front Cover Assembly

D112646 Middle Case

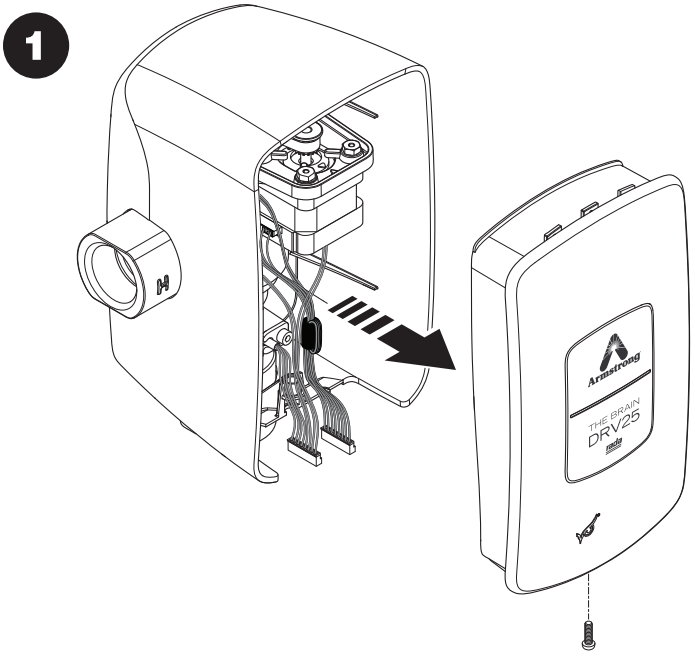
D112645 Drive Mechanism Assembly

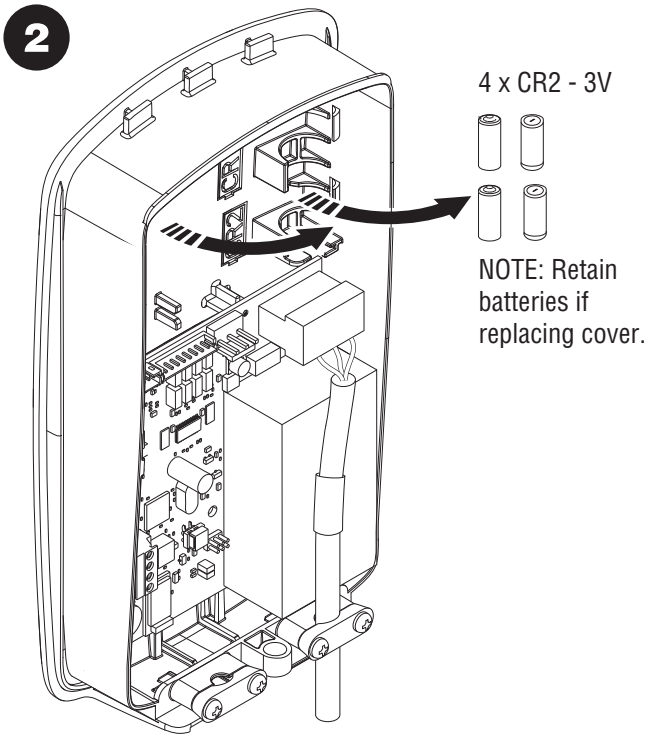
D112646 Rear Case

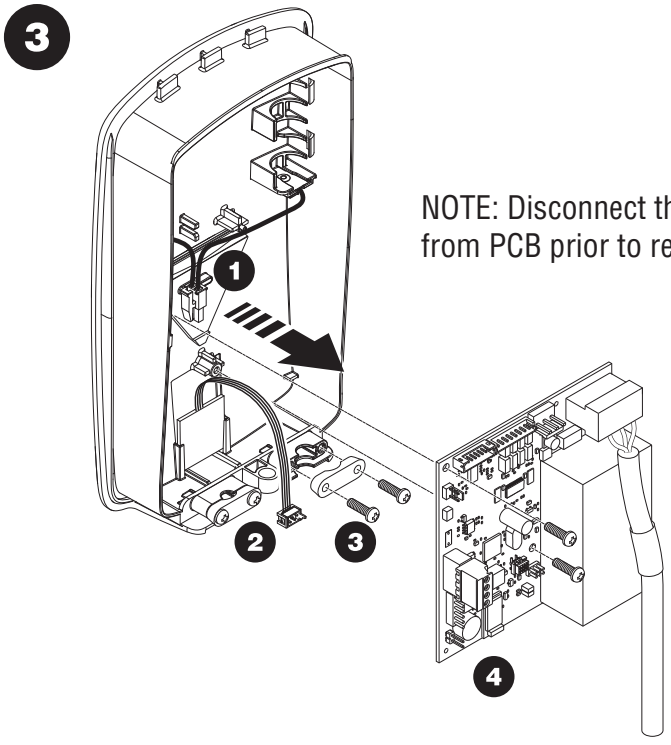


DRV Spare Parts, cont.

18.4 - DRV25 Disassembly of the PCBA from the Front Cover



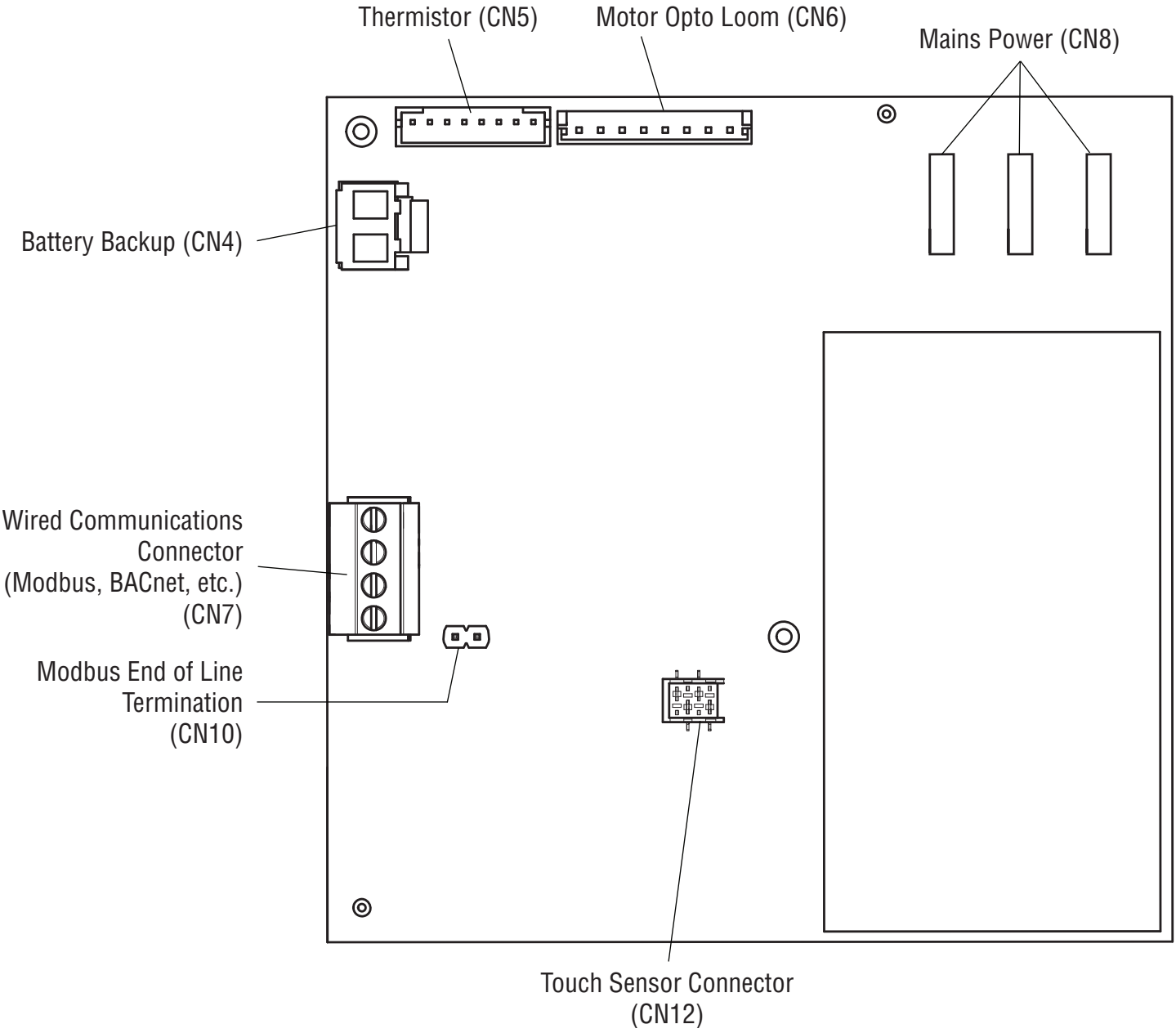




NOTE: Disconnect the battery clip and capacitive touch sensor from PCB prior to removing the PCB from the rear cover.

DRV Spare Parts, cont.

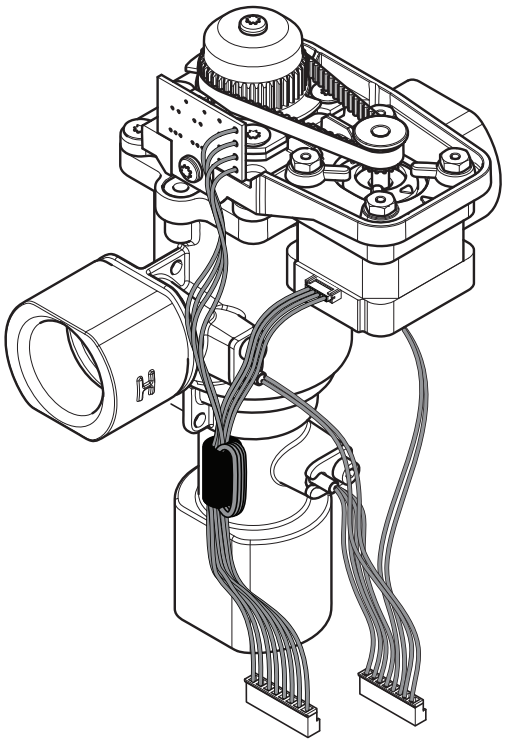
18.5 - DRV25 PCB Connections

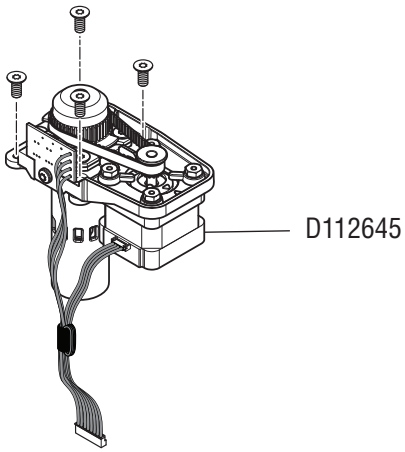


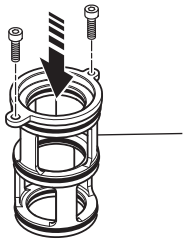
DRV Spare Parts, cont.

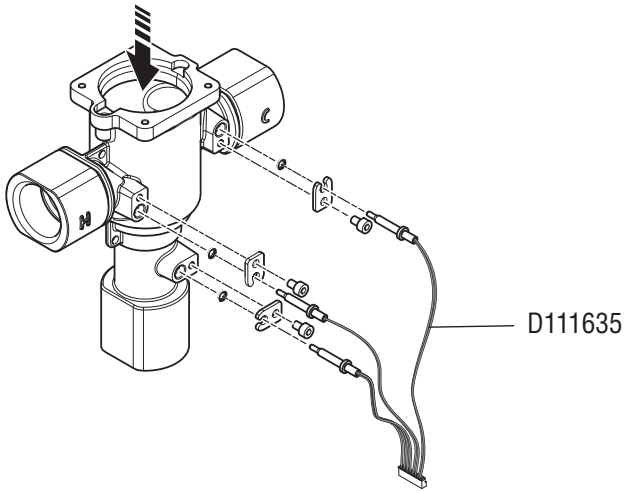
18.6 - DRV25 Drive Mechanism Assembly

D112645	Drive Mechanism Assembly
D112648	Seal Cartridge Assembly
D111635	Thermistor Loom



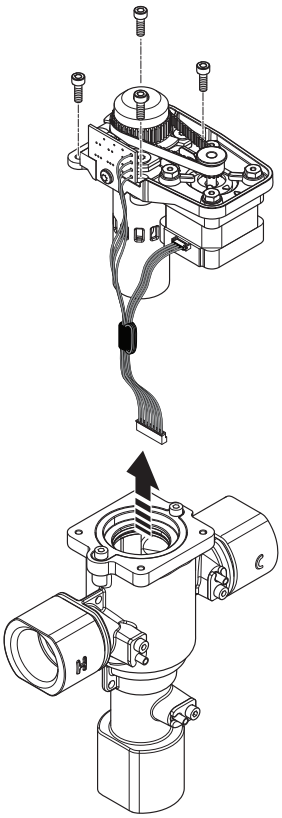






DRV Spare Parts, cont.

1



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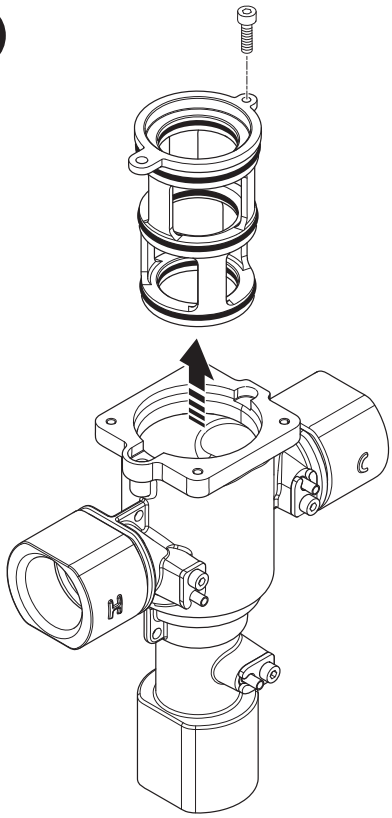

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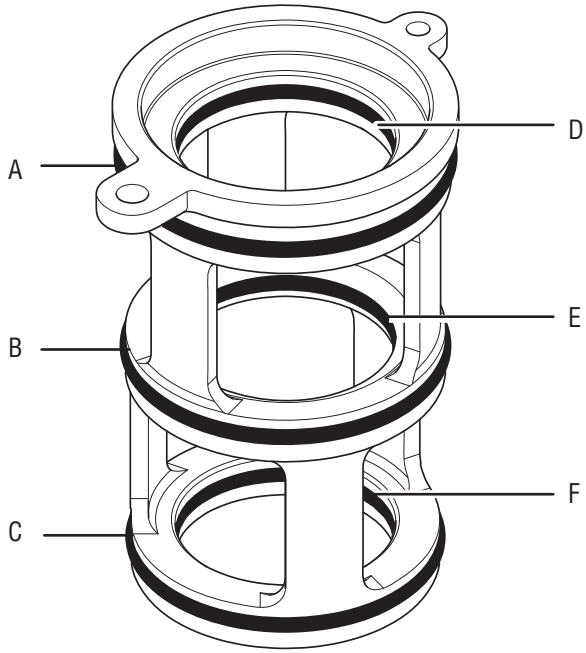

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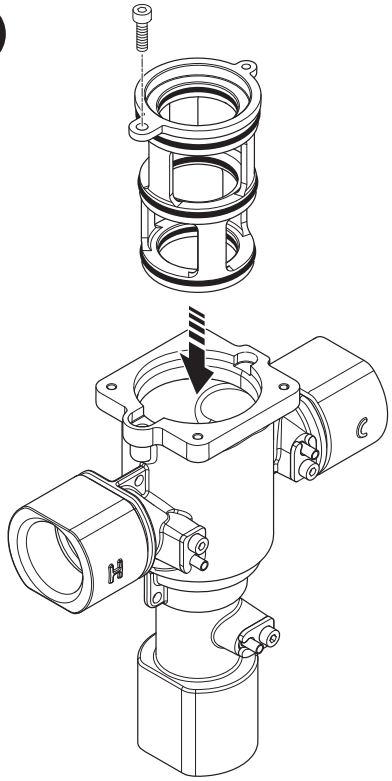
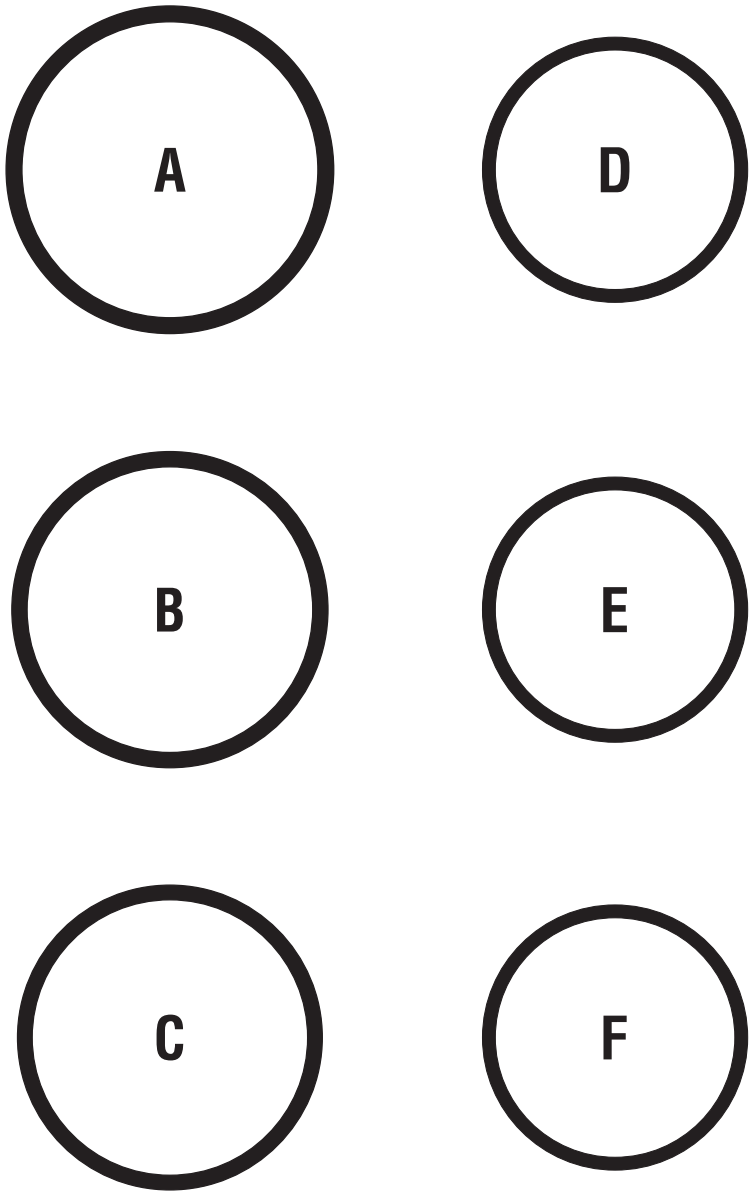


DRV Spare Parts, cont.

Only use silicone-based lubricants on black rubber seals A, B, and C.

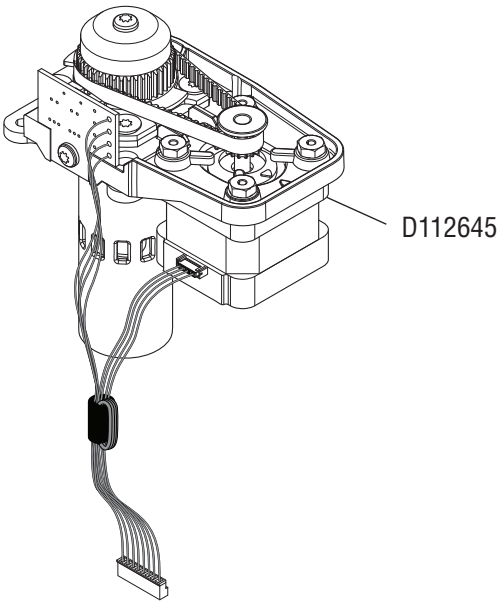


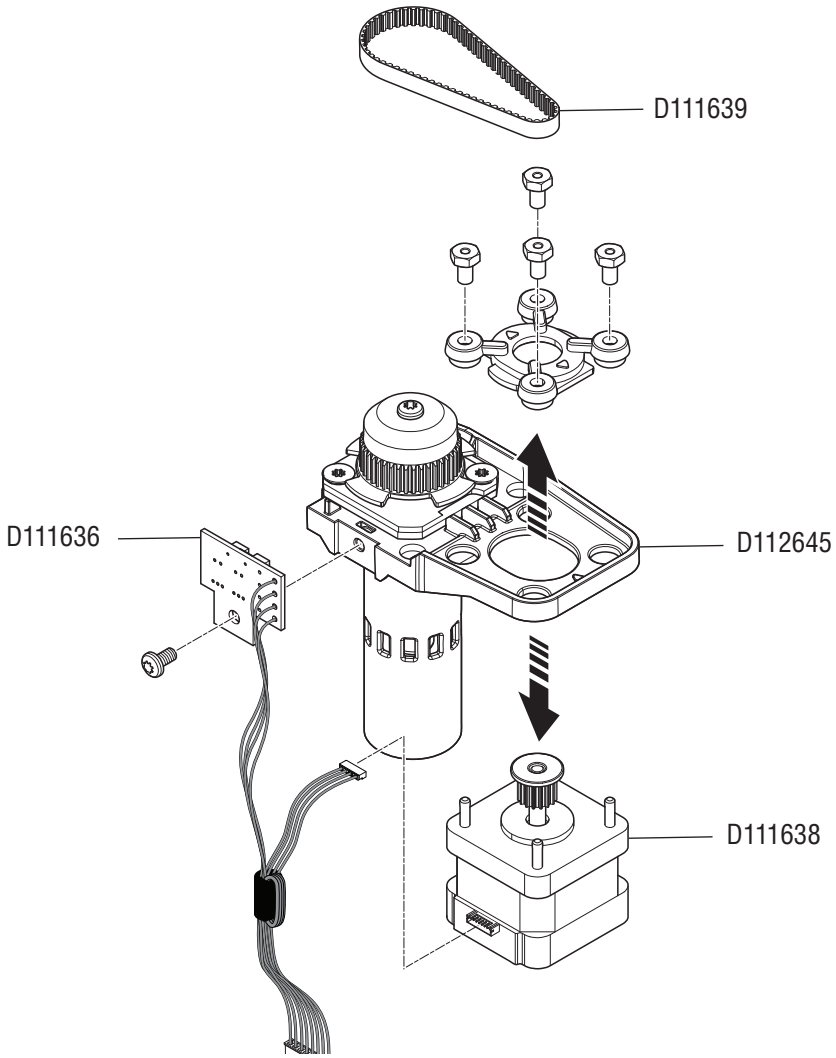
D111634 Service Kit

Seals shown 1:1 when printed at full scale.

DRV Spare Parts, cont.

D111639	Drive Belt
D111636	Dual Opto Motor Loom
D111638	Stepper Motor Assembly
D112645	Drive Mechanism Assembly





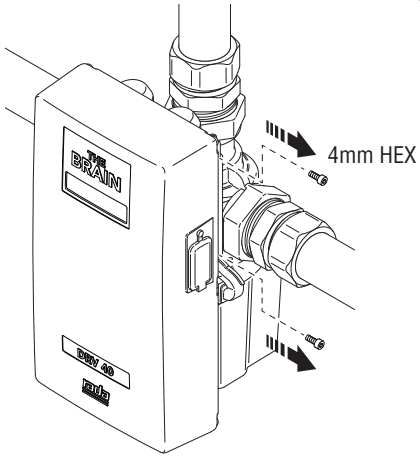
DRV Spare Parts, cont.

18.7 - DRV40 Disassembly

WARNING! Before disassembly, observe the following:

- **Isolate the electrical supply to the DRV25.**
- **Isolate the water supplies to the DRV25.**
- **Allow the hot water inlet to cool sufficiently to reduce the risk of injury through contact with the hot pipe or DRV.**

1



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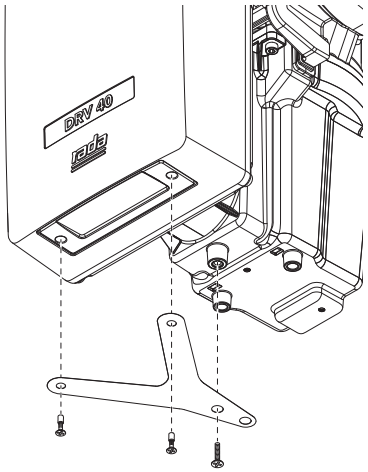

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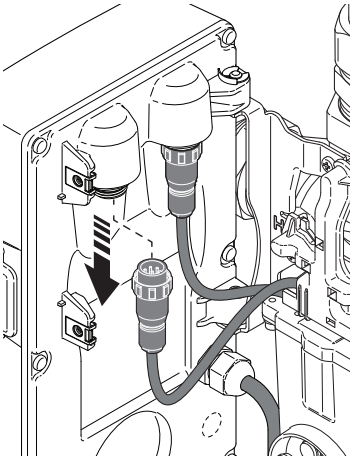
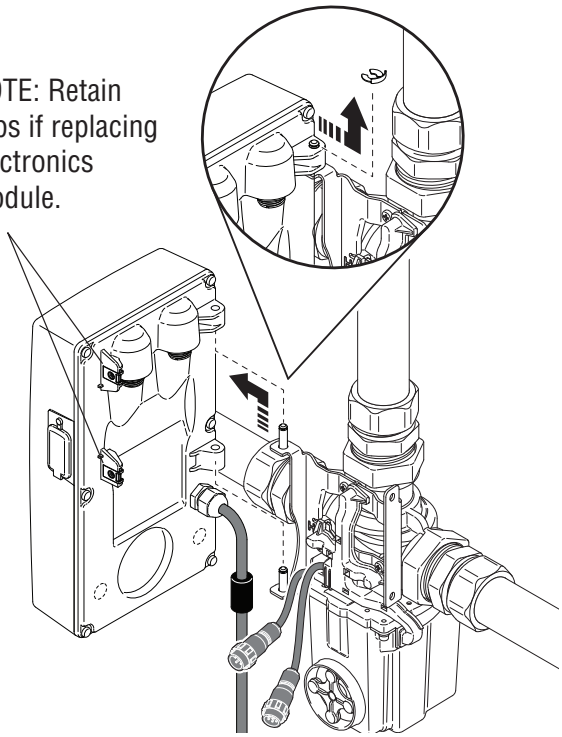


Failure to disconnect the incoming power supply before removing the plugs may result in product damage. Any damage caused this way is not covered by the limited warranty. See the **Warranty** for full details.

4

NOTE: Retain clips if replacing electronics module.



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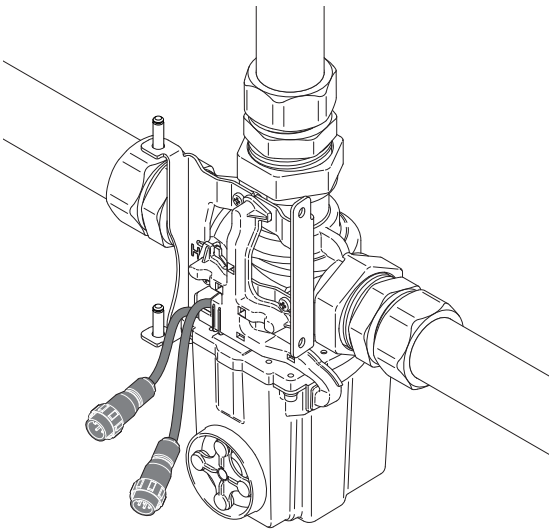
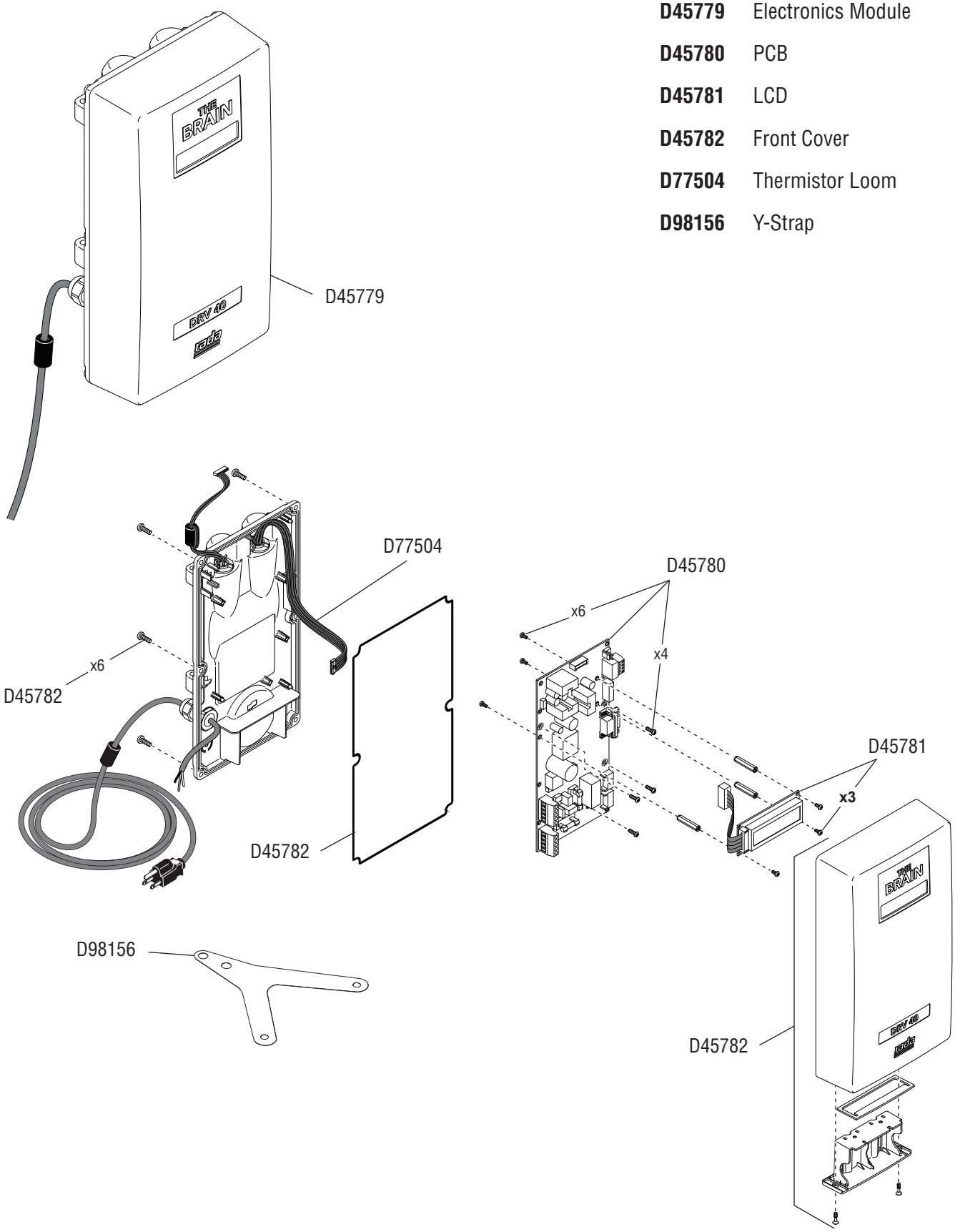


DRV Spare Parts, cont.

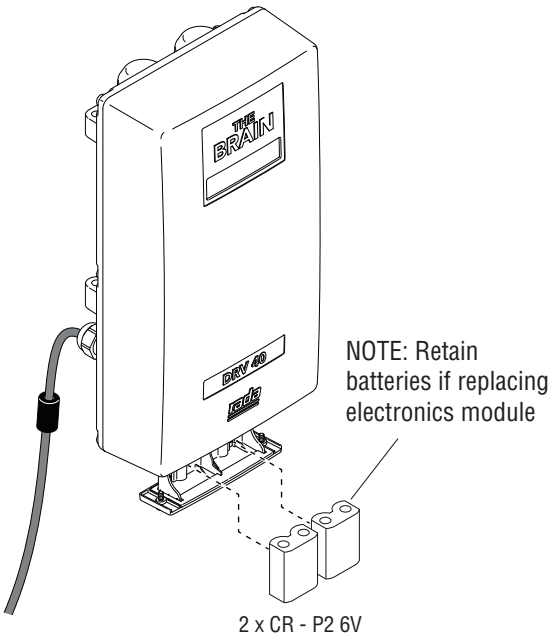
18.8 - DRV40 Electronics Module

D45779	Electronics Module
D45780	PCB
D45781	LCD
D45782	Front Cover
D77504	Thermistor Loom
D98156	Y-Strap



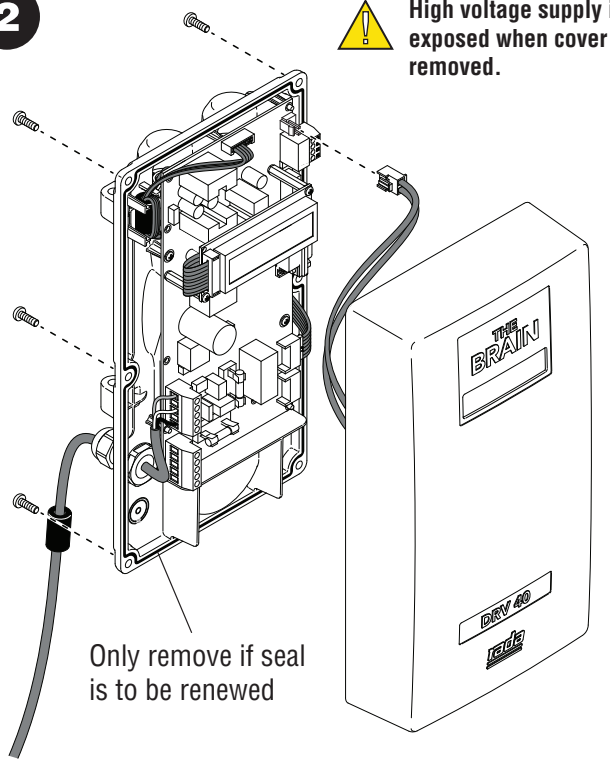
DRV Spare Parts, cont.

1



2

High voltage supply is exposed when cover is removed.



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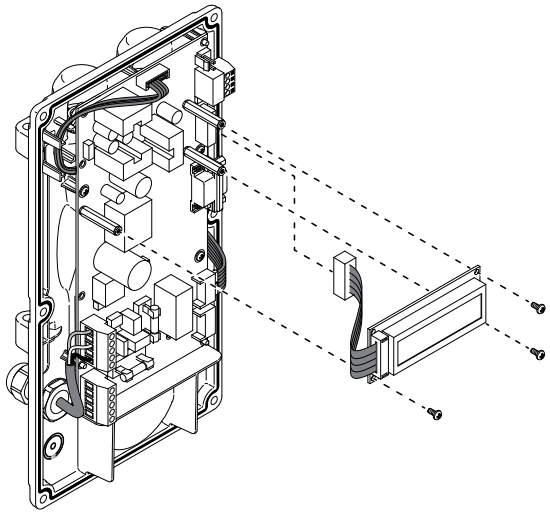

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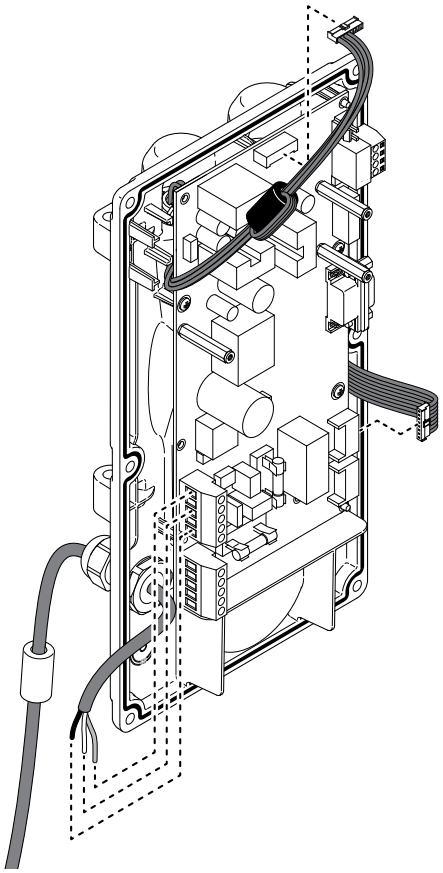
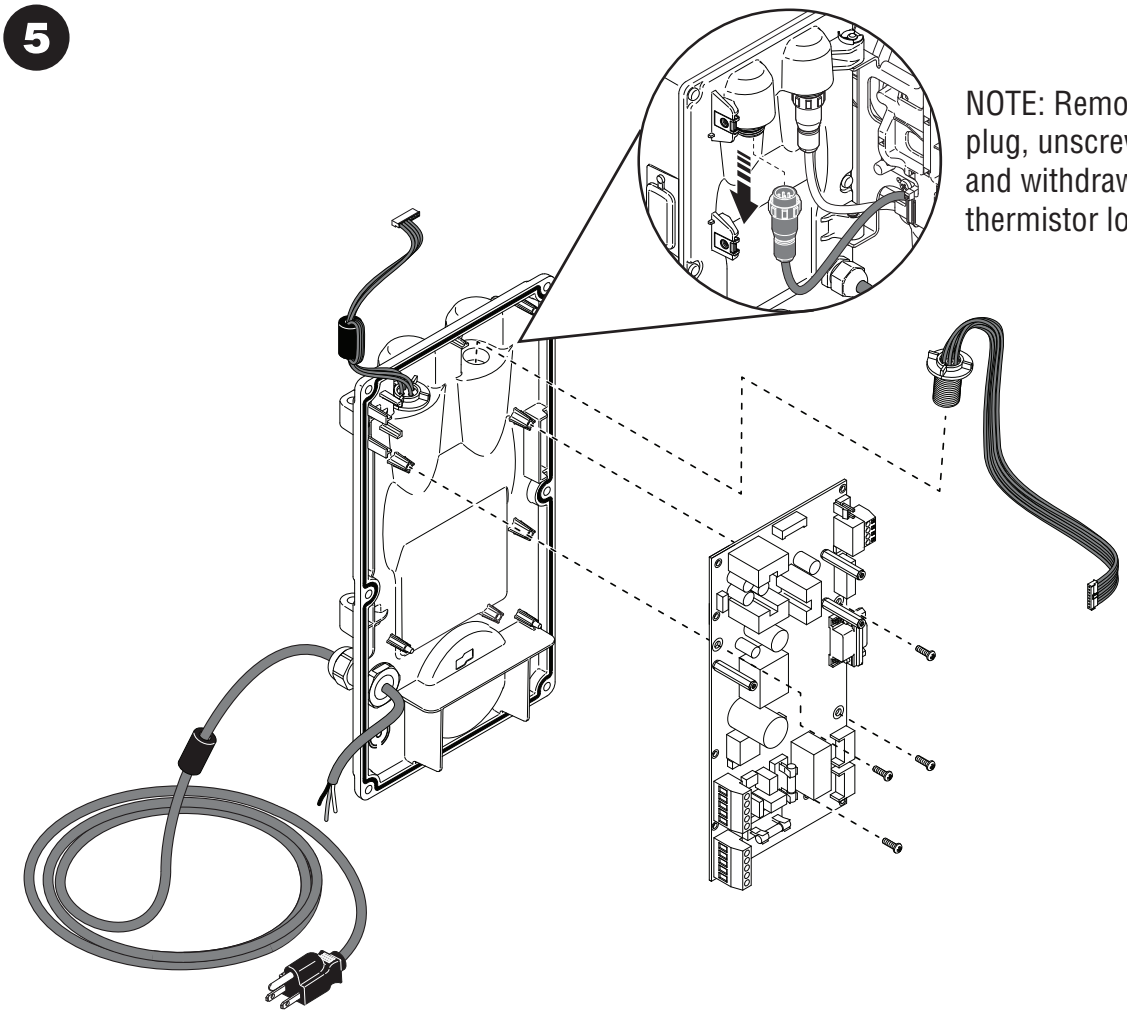


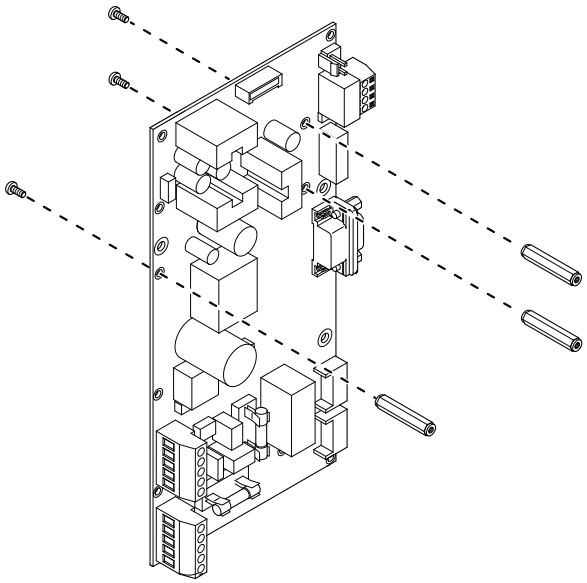
DRV Spare Parts, cont.

5



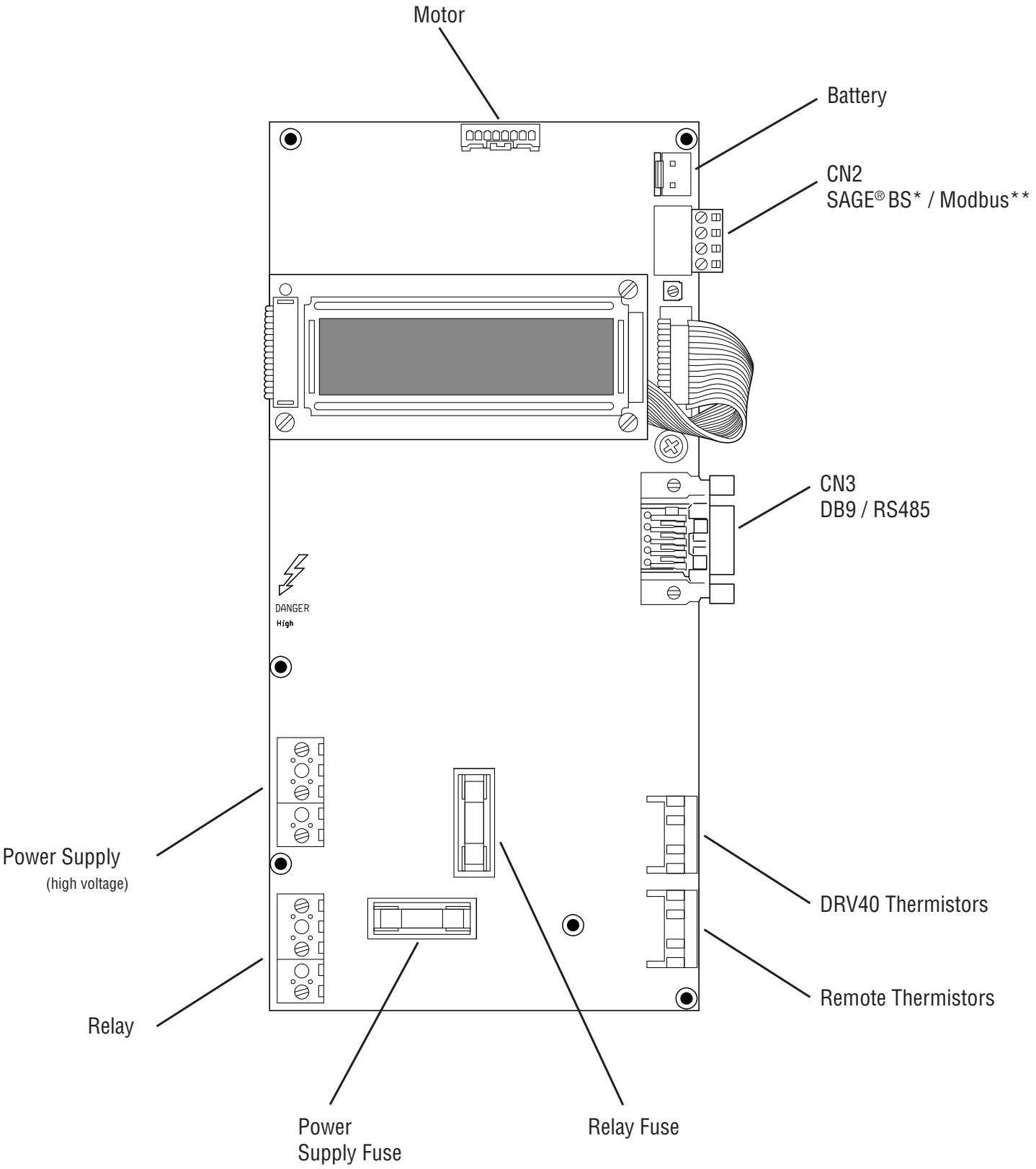
NOTE: Remove 8 pin plug, unscrew locknut, and withdraw the thermistor loom.

6

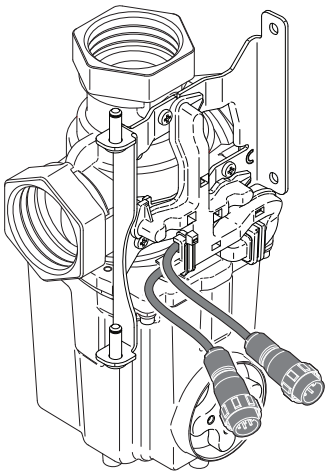


DRV Spare Parts, cont.

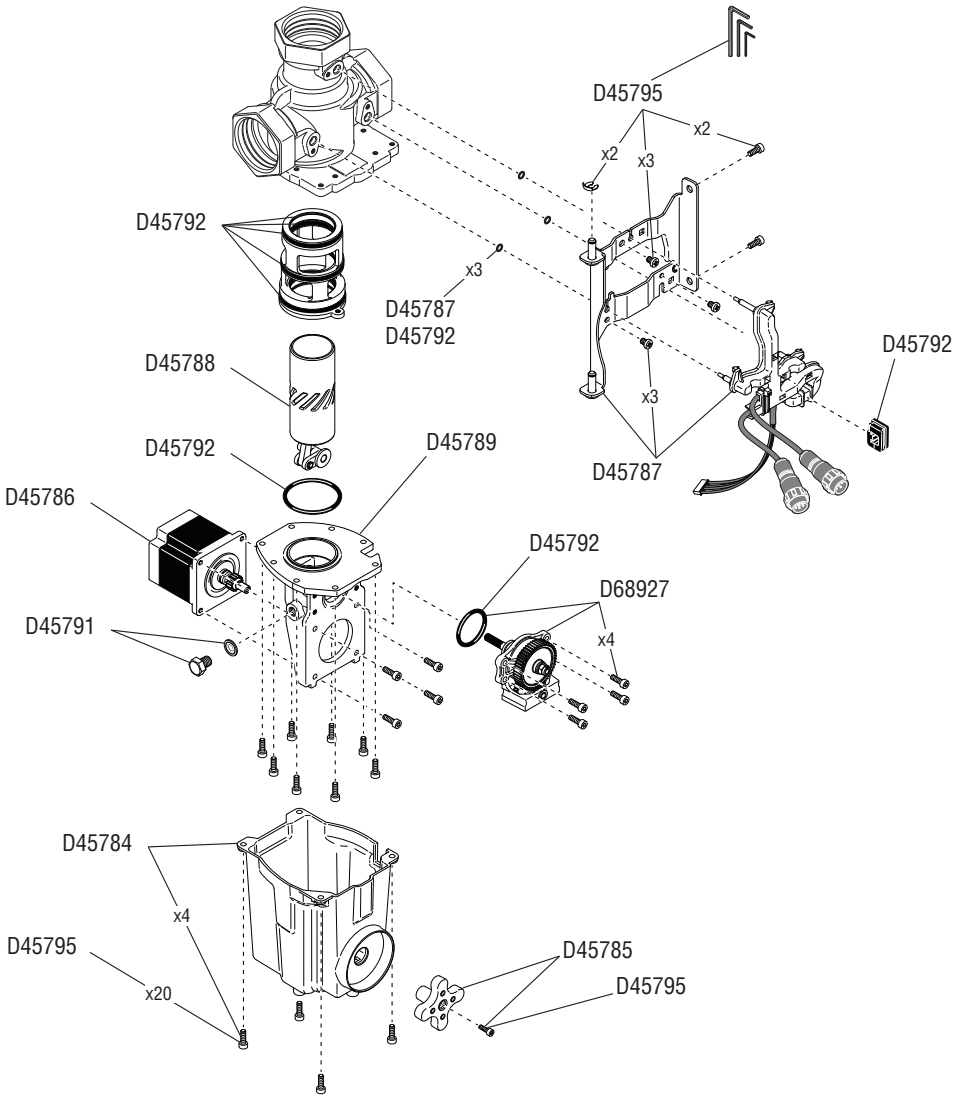
18.9 - DRV40 PCB Connections



DRV Spare Parts, cont.

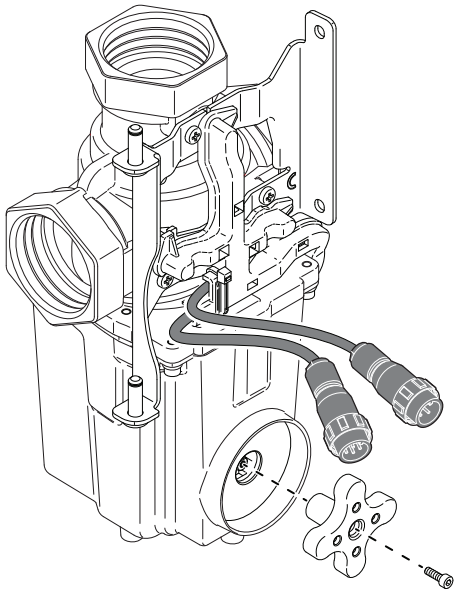


D45784	Motor Cover
D45785	Magnetic Rotor
D45786	Stepper Motor
D45787	Cable Loom Assembly
D45788	Proportioning Assembly
D45789	Drive Housing
D68927	Gear Drive Assembly
D45791	Drain Plug
D45792	Seal Pack
D45795	Screw Pack



DRV Spare Parts, cont.

1



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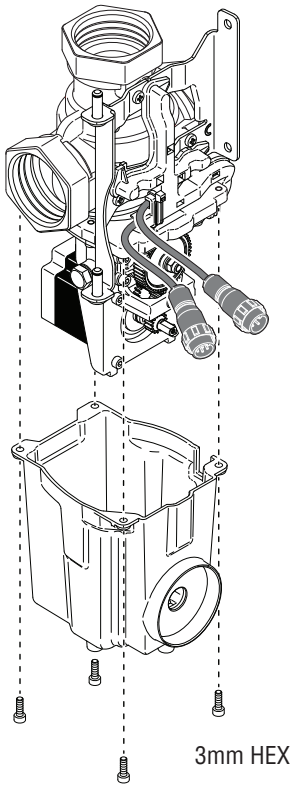

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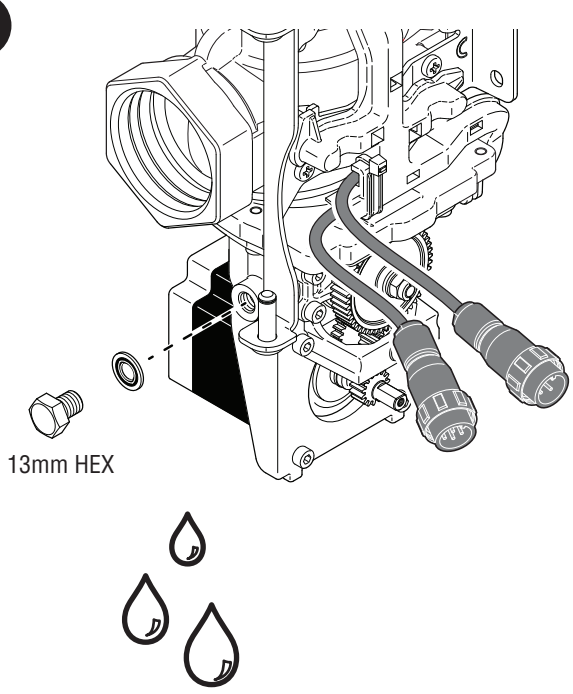

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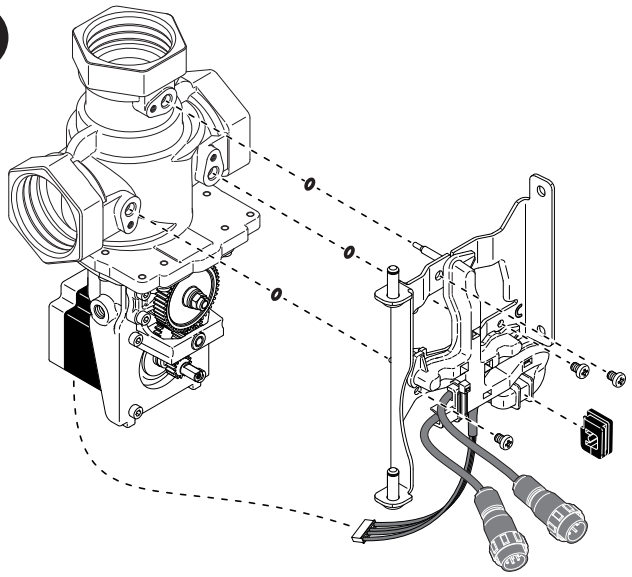
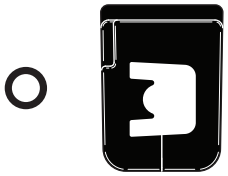
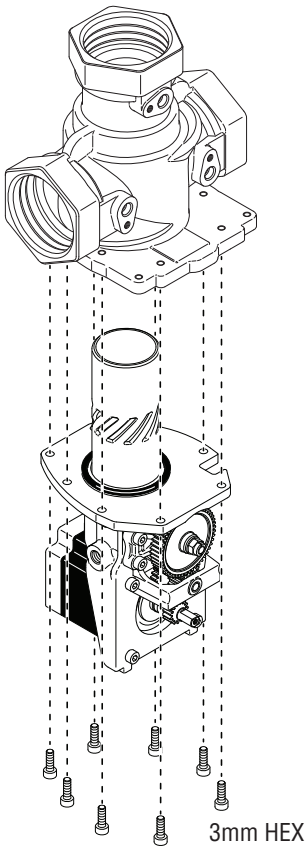




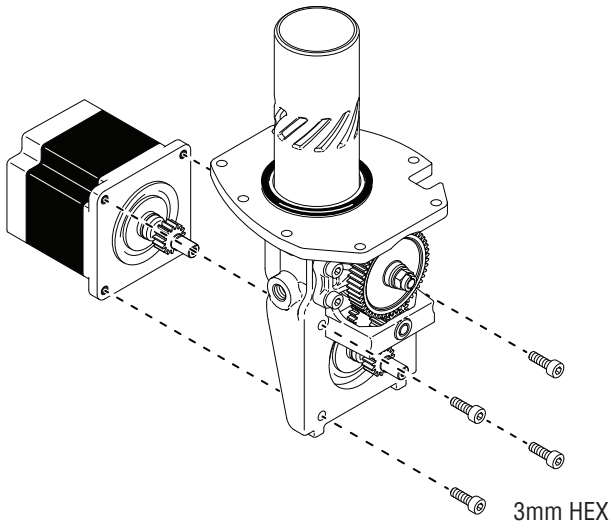
Seals shown 1:1
when printed at full scale.

DRV Spare Parts, cont.

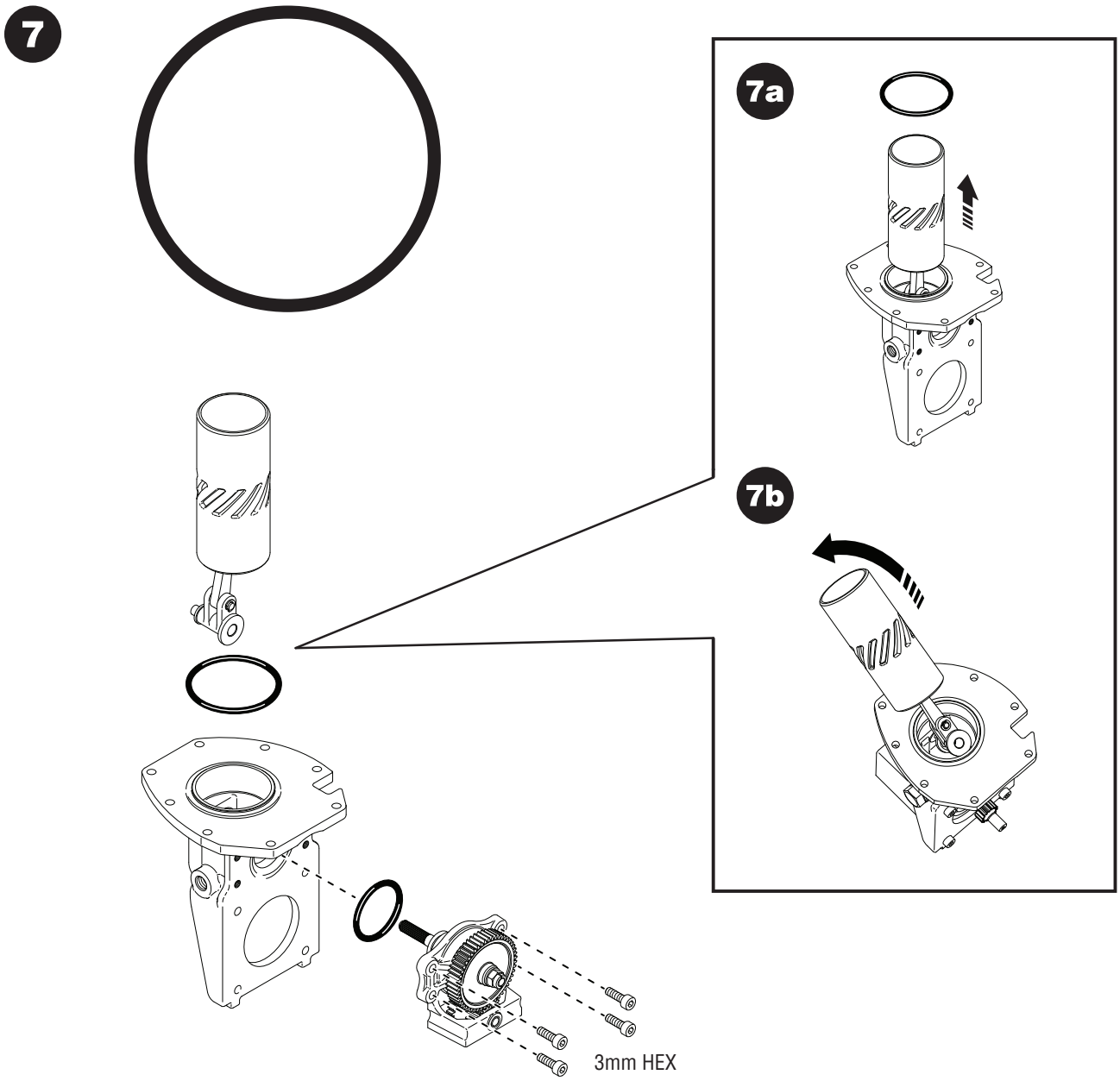
5



6



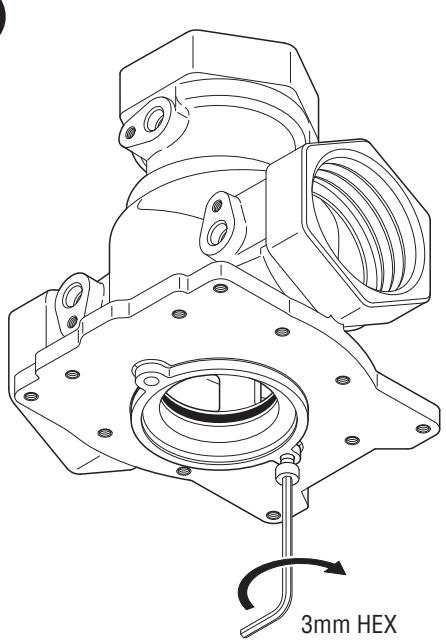
DRV Spare Parts, cont.



Seals shown 1:1
when printed at full scale.

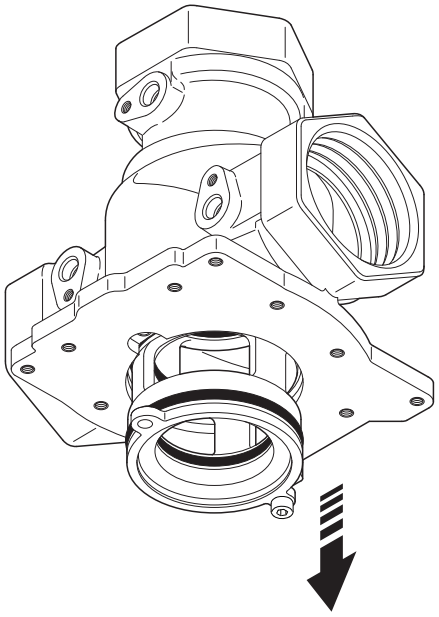
DRV Spare Parts, cont.

8



Use one of the 3mm Hex screws to assist in removing the cartridge.

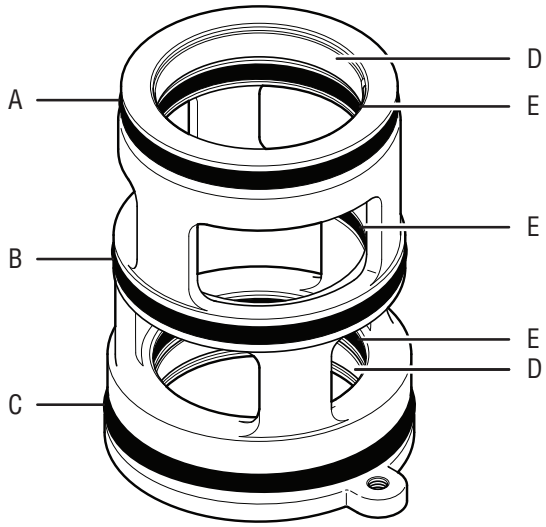
9



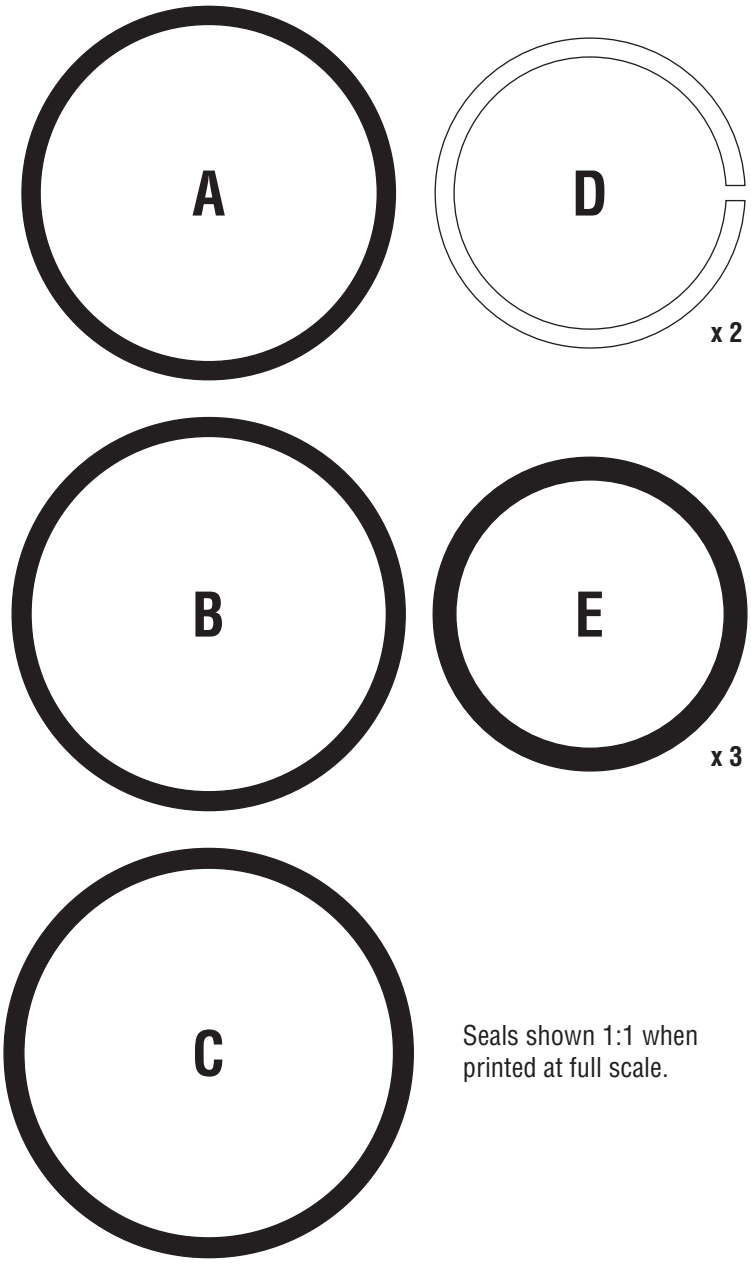
⚠ Cartridge will fall when loose.

DRV Spare Parts, cont.

10



D45792 Seal Pack

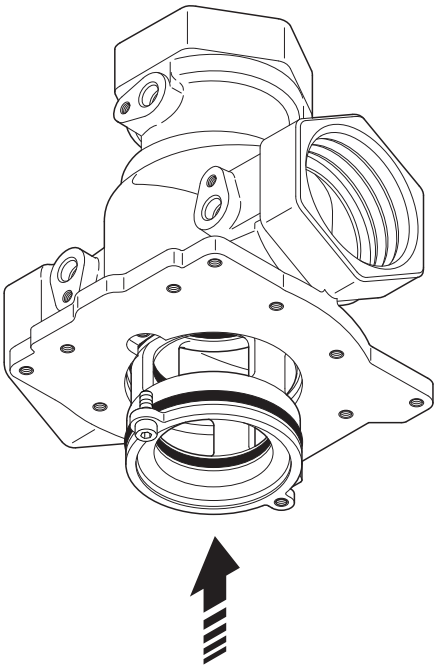


Only use silicone-based lubricants on rubber seals.

Seals shown 1:1 when printed at full scale.

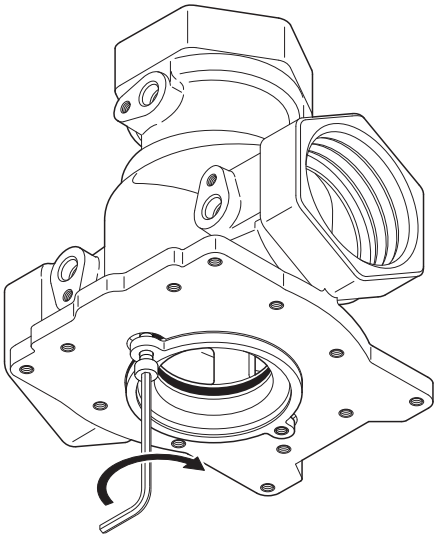
DRV Spare Parts, cont.

11



Use one of the 3mm Hex screws to assist in refitting the cartridge. Remove the screw when the cartridge is inserted fully.

12

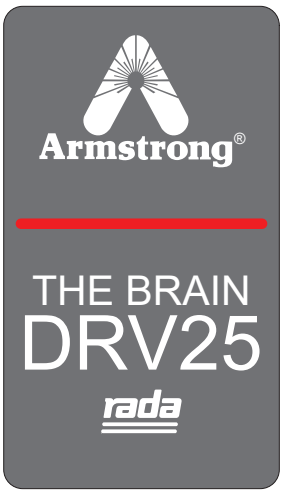


3mm HEX

19.0 - Troubleshooting

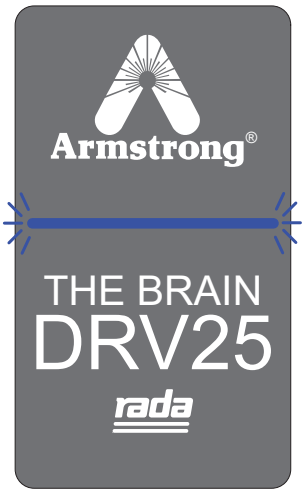
19.1 - DRV LED Indications

NOTE: References in this section made to DRV25 will also apply to DRV40 valves.

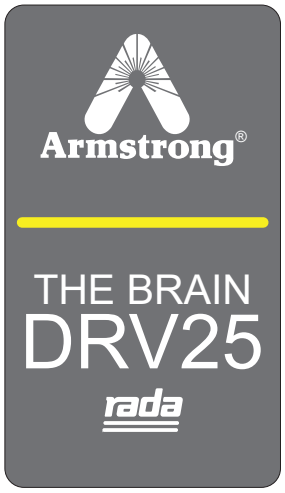


Error Condition

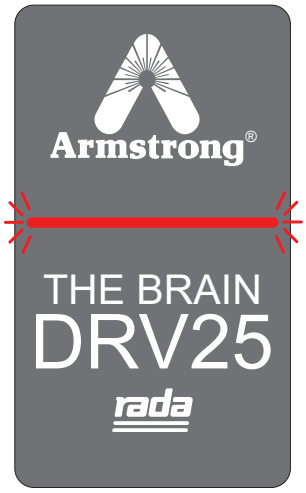
On & Good



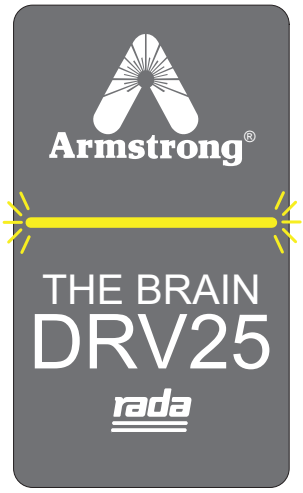
BLE Pairing Mode



Off
(Recirculation)



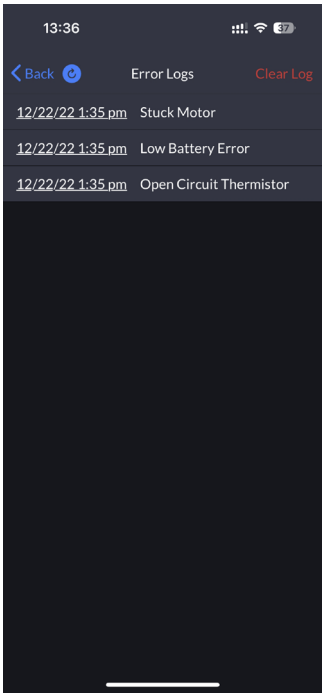
Thermal Disinfection



Emergency Mode

Troubleshooting, cont.

19.2 - DRV Errors



A rolling list of 10 errors is maintained within the DRV25 memory to show historical error events. These records are date and time stamped for reference and can be used to help diagnose on-going issues with the product or system and can be accessed through the SAGE® App.

19.2.1 - DRV Battery Error

The following errors indicate the batteries are discharged / flat or disconnected. Check for the following:

- Batteries are securely connected through connector CN4 to PCBA
- Battery connections show signs of wear or debris /corrosion
- Batteries are at minimal power or flat
- Replace batteries (see Preventative Maintenance and Fitting Spare Parts on **Page 91** (DRV25) and **Page 100** (DRV40). DO NOT use rechargeable batteries). Ensure only Duracell Lithium CR2 batteries are used (P/N - D112402).

If the battery terminals show signs of corrosion or damage, replace: P/N - D112643 Front Cover Assembly with PCBA see **Pages 93 -95**.

Troubleshooting, cont.

19.2.2 - Emergency Mode / Motor Error

Maintenance to the DRV internal mechanism is required. DRV continues to operate safely, but with reduced performance. Check for the following:

- Motor damage or signs of wear
- Proportioning Assembly damage or signs of wear
- Debris in the Drive Assembly

If this mode is not addressed then it is likely the DRV will stop working and develop into a critical motor error.

The following symptoms indicate motor / cable loom failure or a malfunction of the positioning sensor. In the first instance, power cycle/reboot the DRV. If the error persists, check for the following:

- Internal PCBA connectors to DRV are disconnected, damaged or possibly wet
- Dirt or debris around motor
- Motor is disconnected
- Opto encoder is not coupled to the motor
- Proportioning Assembly is sticking or has seized
- Motor is loose
- Drive belt is loose or dislodged

Replace in the following order if the problem still persists after each:

1. P/N - D111636 Dual Opto Motor Loom
2. P/N - D111639 Drive Belt
3. P/N - D112643 Front Cover Assy with PCBA
4. P/N - D111638 Stepper Motor
5. P/N - D112645 Drive Mechanism Assy see **Pages 93 - 99**.

Troubleshooting, cont.

19.2.3 - PCB Errors (Terminal)

The following errors indicate the PCB has failed. Replace the Front Cover Assembly with PCBA. P/N - D112643 Front Cover Assembly with PCBA see **Pages 93-94**.

- Unconfigured error
- A2D range error
- General A2D error
- EEPROM error

19.2.4 - PCB Errors (Recoverable)

The following errors indicate the PCB has failed, but may be recoverable. Turn power off for 10 seconds and restart. If the error persists, replace the Front Cover Assembly with PCBA. P/N - D112643 Front Cover Assembly with PCBA see **Pages 93-94**.

- A2D timeout
- RAM error
- Real time check error
- Flash error
- Algorithm error
- Controller fault
- Stack error
- Scheduling error
- Capacitive touch sensor error

Troubleshooting, cont.

19.2.5 - Open Circuit Thermistor

Indicates thermistor / cable loom failure. Turn power off for 10 seconds and restart. If the error persists, check for the following.

- Internal PCBA connections to DRV25 are disconnected, damaged or possibly wet
- Thermistors are loose

If the problem persists, replace the thermistor loom. P/N - D111635 Thermistor Loom see **Pages 93-96**.

19.2.6 - Over Temperature

Outlet temperature exceeds the Error Temp value. This condition causes the DRVto switch to full cold. Check for the following:

- Check error temperature limit is set correctly for system
- Internal seal damage
- Debris in the internal mechanism
- Internal mechanism damaged / disconnected
- Thermistor loom damaged

If the problem persists, replace the thermistor loom. P/N - D111635 Thermistor Loom see **Pages 93 -98**.

Troubleshooting, cont.

19.3 - DRV Common Faults

19.3.1 - Problem: Blend temperature rises when system is in zero demand

Check blend circuit flow rate
Flow rate is less than 2 gpm (8 lpm) for DRV25 or 5 gpm (19 lpm) for DRV40. Reset circuit flow rate and check for the following:

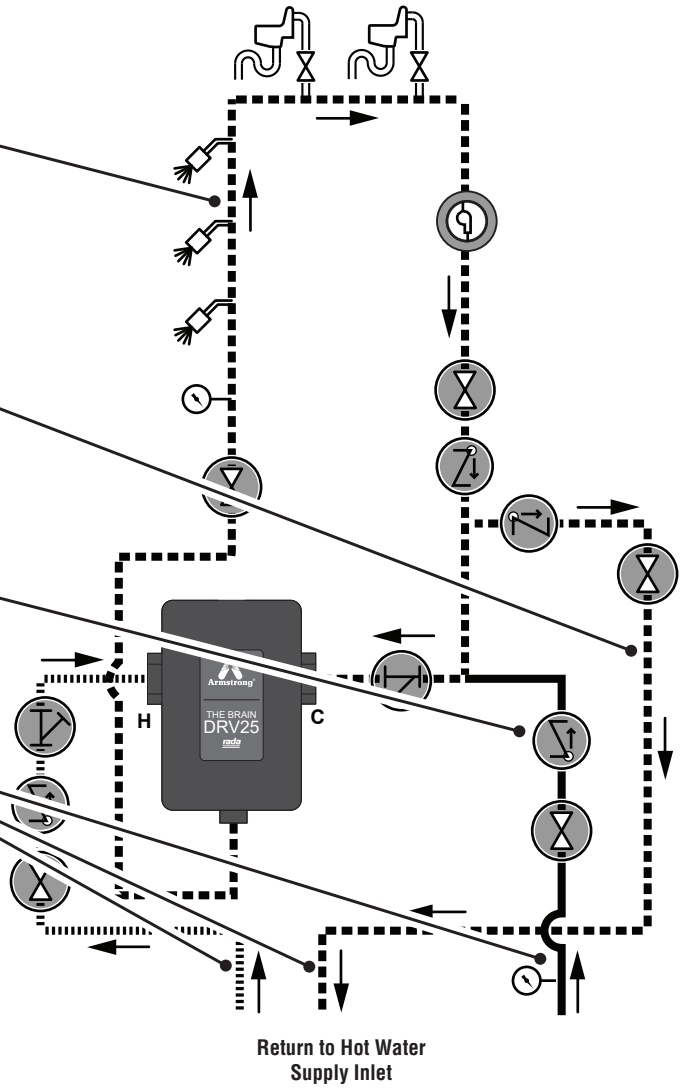
- Air locks
- Blocked strainers
- Closed valves
- Pump failure

Check mixed return temperature under demand.
Minimum recirculation loop temperature loss = 2°F (1°C)

Check Valves
Check circuit to make sure check valves are correctly positioned and operating normally.

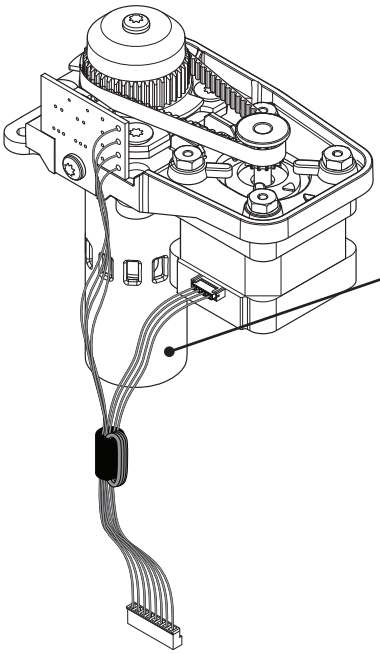
Water Pressure
Make sure supply pressures are balanced. Make sure mixed return is flowing correctly to water heater.

Separator seal
Check separator seal & replace if deteriorated



Troubleshooting, cont.

19.3.2 - Problem: Outlet temperature fluctuates more than ± 2°F



Check internal mechanism
Mechanism is jamming or slow to control. Clean and descale the following parts:

- Proportioning assembly

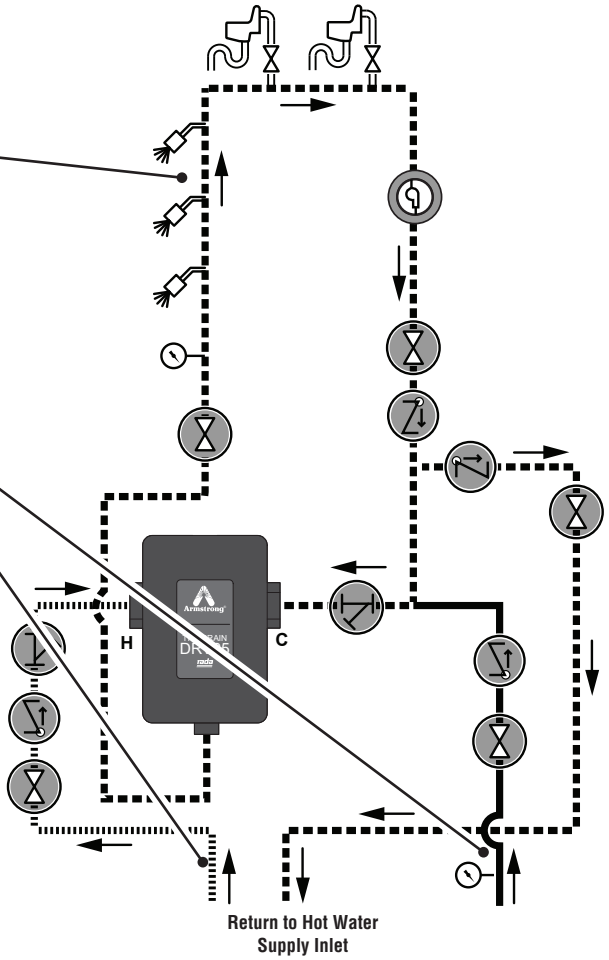
Renew separator seal and lubricate internal mechanism.

Check blend circuit flow rate.
Flow rate is less than 2 gpm (8 lpm) for DRV25 or 5 gpm (19 lpm) for DRV40. Reset circuit flow rate and check for the following:

- Air locks
- Blocked strainers
- Closed valves
- Pump failure

Water pressure
Make sure supply pressures are balanced. Check for the following:

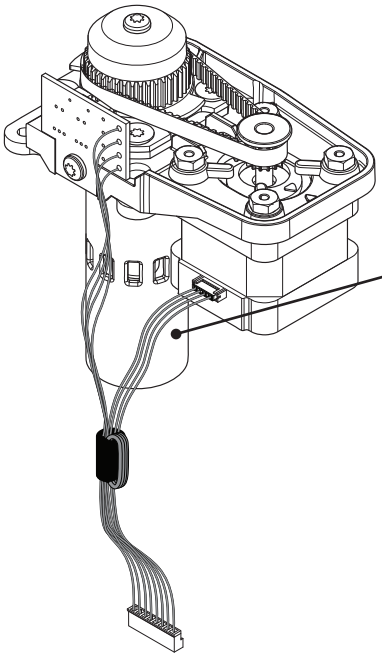
- Air locks
- Blocked strainers
- Closed valves



Troubleshooting, cont.

19.3.3 - Problem: SAGE® Mobile App display shows an overtemperature error

For the most probable causes and solutions see DRV25 Errors on Page 115. If any other error message is displayed see DRV Errors on Pages 115-120.

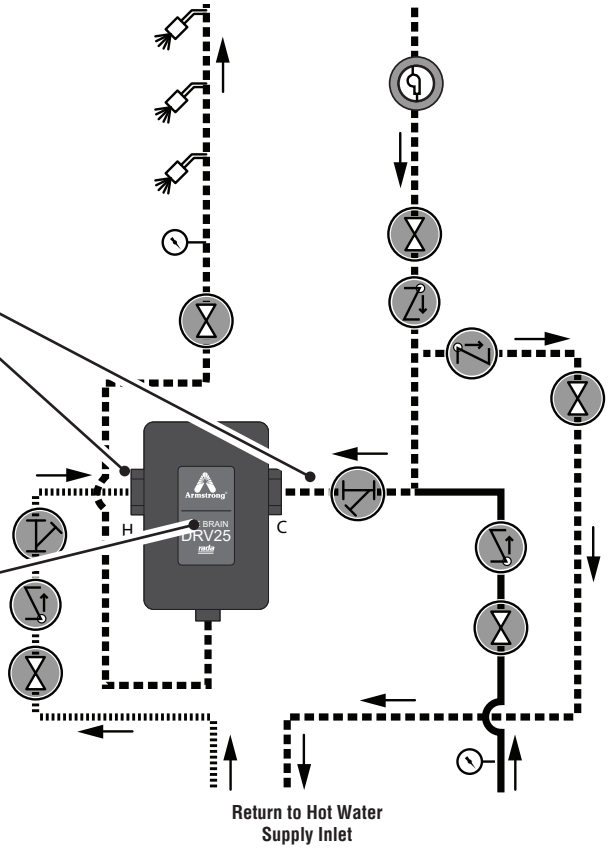


Check internal mechanism
Mechanism is jamming or slow to control. Clean and descale the following parts:

- Proportioning Assembly
- Renew separator seal

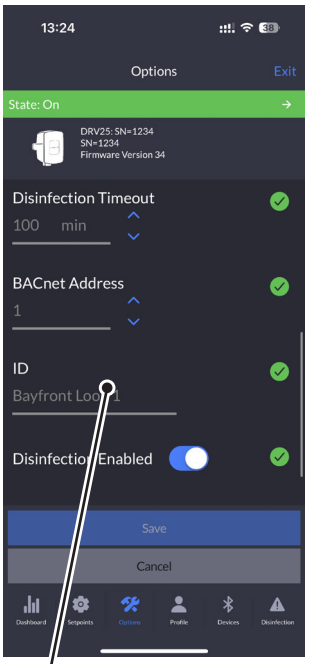
Inlet Water Temperatures
Check water supplies are connected to the correct inlet ports.
Check inlet supply temperature

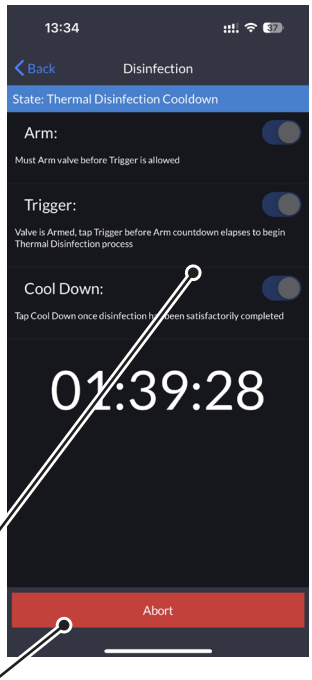
Reset DRV
Turn power off for 10 seconds and restart.



Troubleshooting, cont.

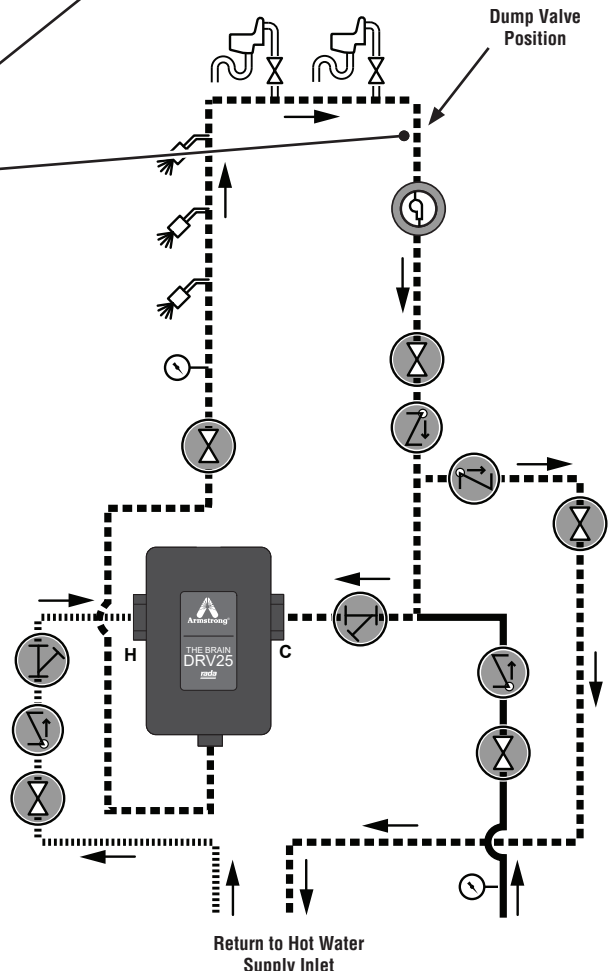
19.3.4 - Problem: Blend circuit does not fully return to normal within the Disinfection Tiemout period





Blend Circuit / Control Software
Check the following:

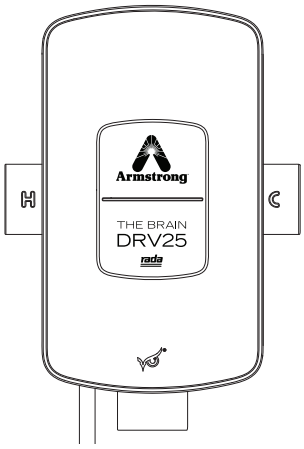
- Disinfection Timeout value.
- Cool Down start and finish times.
- Early abort of disinfection cycle.
- Use of a dump valve to speed up cool down time.

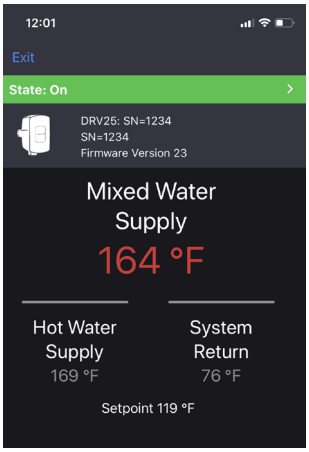


Troubleshooting, cont.

19.3.5 - Problem: Unable to adjust outlet temperature

DRV Errors





For the most probable causes and solutions see DRV Errors on **Pages 115-120**.

If any other error message is displayed see DRV Errors on **Pages 115-120**.

Check blend circuit flow rate
Flow rate is less than 2 gpm (8 lpm) for DRV25 or 5 gpm (19 lpm) for DRV40. Reset circuit flow rate and check for the following:

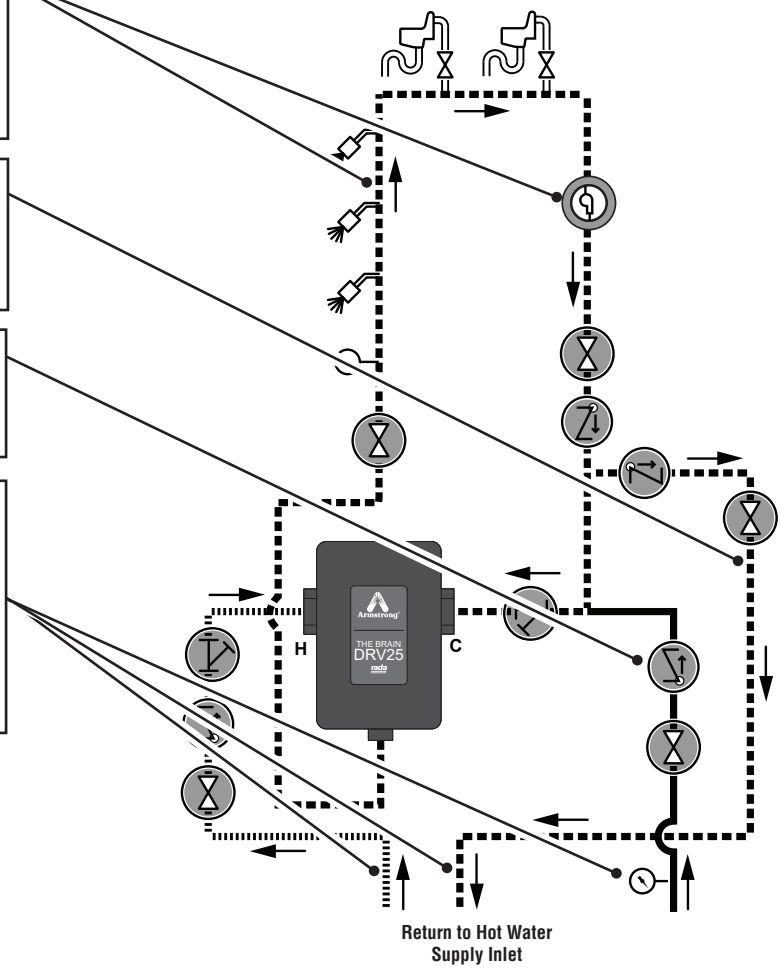
- Air locks
- Blocked strainers
- Closed valves
- Pump failure

Check mixed return temperature under demand.
Minimum recirculation loop temperature loss = 2°F (1°C)

Check Valves
Check circuit to make sure check valves are correctly positioned and operating normally.

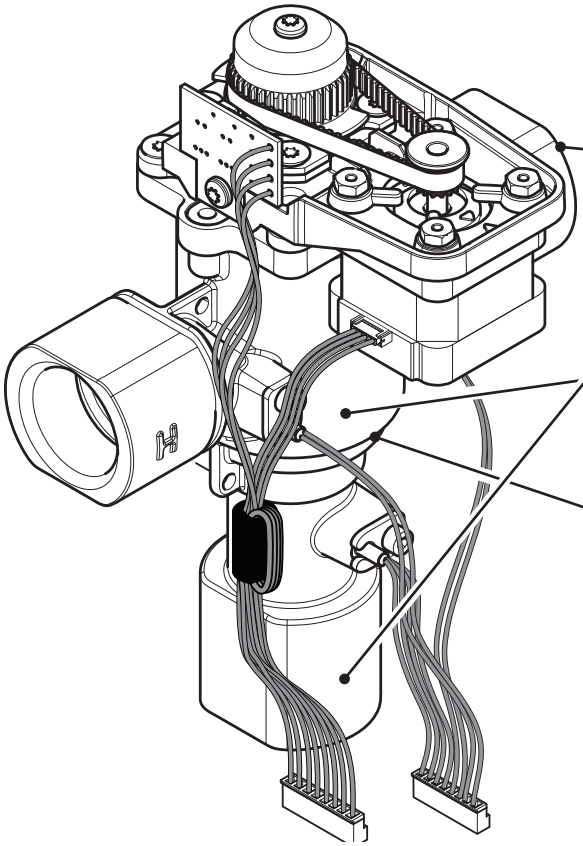
Water Pressure / Flow
Make sure supply pressures are balanced. Make sure mixed return is flowing correctly to water heater.

- Air locks
- Blocked strainers
- Closed valves



Troubleshooting, cont.

19.3.5 - Problem: Water leaking from DRV25



Check inlet and outlet connections
Check inlet and outlet thread joints. Check a correct seal has been made with PTFE thread sealing tape or liquid sealant. Oil-based, non-setting joint compounds should not be used.

DRV body failure
DRV replacement required.

Check all DRV seals
Check all internal seals for wear and / or damage. Clean and refit seals (see **Page 97**).

Limited Warranty and Remedy

Armstrong International, Inc. or the Armstrong division that sold the product ("Armstrong") warrants to the original user of those products supplied by it and used in the service and in the manner for which they are intended, that such products shall be free from defects in material and workmanship for a period of one (1) year from the date of installation, but not longer than 15 months from the date of shipment from the factory, [unless a Special Warranty Period applies, as listed below]. This warranty does not extend to any product that has been subject to misuse, neglect or alteration after shipment from the Armstrong factory. Except as may be expressly provided in a written agreement between Armstrong and the user, which is signed by both parties, Armstrong **DOES NOT MAKE ANY OTHER REPRESENTATIONS OR WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR ANY IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.**

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Special Warranty Periods are as follows:

The Brain® Model DRV25 and DRV40 shall have a 5-year parts warranty on all components other than preventative maintenance service items, which includes batteries and all 'wetted' O-rings/seals.

Notes

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ASCEND® On-Demand Water Heater Installation, Operation and Maintenance Manual

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