

SA-SERIES

Direct Gas-Fired

Industrial Blow-Thru® Space Heater

Technical Manual

⚠ WARNING:

Improper installation, adjustment, alteration, service or maintenance can cause property damage, injury or death. Read the installation, operating, and maintenance instructions thoroughly before installing or servicing this equipment.

FOR YOUR SAFETY

The use and storage of gasoline or other flammable vapors and liquids in open containers in the vicinity of this appliance is hazardous.

FOR YOUR SAFETY

If you smell gas:

1. Open windows.
2. Don't touch electrical switches.
3. Extinguish any open flame.
4. Immediately call your gas supplier.

Made in the USA



LIMITED WARRANTY

Cambridge Air Solutions (“Manufacturer”) warrants that its products (“the Products”) to be free from defects in material and workmanship. Manufacturer’s SA-Series Products shall be warranted for a period of 24 months from the date of shipment, except that burner assemblies are warranted for five years from date of shipment.

Buyer’s sole and exclusive remedy for any nonconformity with this warranty shall be, at Manufacturer’s option, repair or replacement of nonconforming parts, provided that Buyer shall return to Manufacturer, shipping prepaid, said non-conforming part(s) bearing a durable tag indicating the Serial Number of the Product from which the part was taken. In addition, Manufacturer may opt not to repair or replace nonconforming Product or part(s), but instead may refund to Buyer the price thereof, in lieu of repair or replacement. In no event shall Manufacturer be liable for more than a refund of the purchase price or replacement value of the Product or part(s), whichever is less. This Warranty does not apply to field labor charges.

This Warranty does not apply and shall be void as to any Products that are misused or misapplied, that are installed, operated or maintained not in conformity with Manufacturer’s design, specifications, instructions, or Technical Manual, or are installed, operated or maintained in violation of any applicable national or local codes or industry standards.

Manufacturer does not warrant Products, if they are abused, improperly operated or maintained, subjected to abnormal wear and tear, damaged due to improper gas or electric service, damaged in transit, or that have been repaired or modified by others without Manufacturer’s written authorization.

Buyer shall have no right to enforce this Warranty unless it has complied with all of its obligations under the contract for purchase/lease of the Products, including without limitation, being current on all payment terms.

THIS LIMITED WARRANTY IS MANUFACTURER’S ONLY WARRANTY WITH RESPECT TO THE PRODUCTS, AND IT IS IN LIEU OF AND SUPERSEDES ANY AND ALL OTHER WARRANTIES OF ANY KIND WHATSOEVER, WHETHER WRITTEN, ORAL OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. THE REMEDIES AFFORDED BUYER BY THIS WARRANTY ARE THE ONLY REMEDIES AFFORDED BUYER FOR ANY NONCONFORMITY WITH THIS WARRANTY OR FOR ANY DEFECT IN PRODUCTS, SERVICES, OR REPRESENTATIONS PROVIDED BY MANUFACTURER IN CONNECTION WITH SUCH PRODUCTS. IN NO EVENT SHALL MANUFACTURER BEAR ANY LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND WHATSOEVER, INCLUDING WITHOUT LIMITATION PERSONAL INJURY (INCLUDING DEATH), PROPERTY DAMAGE, LOST PROFITS OR OTHER ECONOMIC LOSS.

Buyer acknowledges that the foregoing warranty, limitations, and exclusions are a reasonable allocation of commercial risks by and among sophisticated business entities and are not subject to dispute as to their commercial reasonableness, fairness or ability to satisfy the essential purposes of the parties’ transaction.

**SA-SERIES
BLOW-THRU® SPACE HEATER
TECHNICAL MANUAL**

Contents	
Hazard Summary	2
General Installation Instructions	3
Uncrating Instructions.....	3
Mounting Location.....	3
Typical System Overview	4
Accessory Identification.....	4
Heater Operation	5
Heater Configuration	5
Roof Top Mounting.....	6
Thru Wall Mounting.....	8
Under Roof Mounting.....	10
Gas Piping	12
Electrical Wiring	13
Start-up Instructions.....	14
Shutdown Instructions	17
Calibration Procedure	17
Operating Instructions.....	19
Operating Sequence	19
TSS Controller	20
Troubleshooting Instructions	29
Troubleshooting Guide.....	29
Reference	35
Electrical Control Enclosure	35
Electrical Wiring Diagrams.....	36
Electrical Connection Diagram	38
Individual Component Descriptions	39
ANSI/ASHRAE/IESNA Standard 90.1	42

HAZARD SUMMARY

Hazard Identification

Warnings and Cautions appear at appropriate sections throughout this manual. Read these carefully.

- ⚠ WARNING:** Indicates a potentially hazardous situation which could result in death or serious injury.
- ⚠ CAUTION:** Indicates a potentially hazardous situation which may result in minor or moderate injury. It may also be used to alert against unsafe practices.
- CAUTION:** Indicates a situation that may result in accidents with equipment or property damage only.
-

The following safety precautions apply to the installation, operation, and maintenance of the equipment described by this technical manual.

⚠ WARNING:

Any unauthorized modification of this equipment shall void the warranty.

⚠ WARNING:

Only qualified personnel should attempt installation, service, and repair of this equipment. Use extreme caution and observe safety regulations at all times.

⚠ WARNING:

Recirculation of room air is not permitted.

Adequate building relief must be provided so as to not over pressurize the building when the heating system is operating at its rated capacity. It should be noted that this can be accomplished by taking into account, through standard engineering methods, the structure's designed infiltration rate, by providing properly sized relief openings, or by interlocking a powered exhaust system, or by a combination of these methods.

If the failure or malfunction of this heater creates a hazard to other fuel burning equipment in the building, (e.g. when the heater is providing the make-up air to a boiler room), the unit is to be interlocked to open inlet air dampers or other such devices.

If the heater is installed such that an inlet duct is

utilized, the duct system must be purged with at least four air changes prior to an ignition attempt.

Installation in Aircraft Hangars

Refer to the Standard for Aircraft Hangars, ANSI/NFPA 409, for specific information on the installation requirements for these heaters in aircraft hangars.

Installation in Parking Garages

Refer to the Standard for Parking Structures, ANSI/NFPA 88A, or the Standard for Repair Garages, ANSI/NFPA 88B, for specific information on the installation requirements for these heaters in public garages.

IMPORTANT

If in doubt regarding installation application, contact Cambridge Customer Service Group at 1-800-473-4569 during the hours of 8:00 a.m. to 5:00 p.m. Central Time, Monday through Friday.

GENERAL INSTALLATION INSTRUCTIONS

UNCRATING INSTRUCTIONS

1. Verify that the number of items on the Bill of Lading matches the number of items received.
2. Check for shipping damage.

IMPORTANT

If damage is found, immediately file a claim with the carrier before proceeding further.

3. Check the items received to ensure they agree with the ordering information including verification of data on the unit nameplate.

IMPORTANT

Do not discard any components or accessories.

MOUNTING LOCATION

Verify feasibility of the installation location selected with respect to accessibility to the heater for service and maintenance functions. Ensure the positioning of the heater does not inhibit fork truck operation, storage rack locations, or other operations within the facility. Ensure the heater inlet and outlet are not blocked or severely restricted in any way that would affect the rated airflow through the heater or affect the desired air distribution pattern of the heater.

⚠ WARNING:

It is recommended the heater mounting structure be reviewed and approved by a qualified structural engineer and the roof manufacturer before installing this equipment.

⚠ WARNING:

To prevent contaminated air from being drawn into the heater, install the heater's inlet at least 10 feet from any building exhaust, process exhaust, sewer stacks, or other sources that would allow contaminants to be drawn into the heater. Consult local codes for additional references.

IMPORTANT

Where the mounting height of the heater is required to be above 15 feet, work platforms or service lifts should be provided for accessibility to the equipment for service and maintenance activities.

IMPORTANT

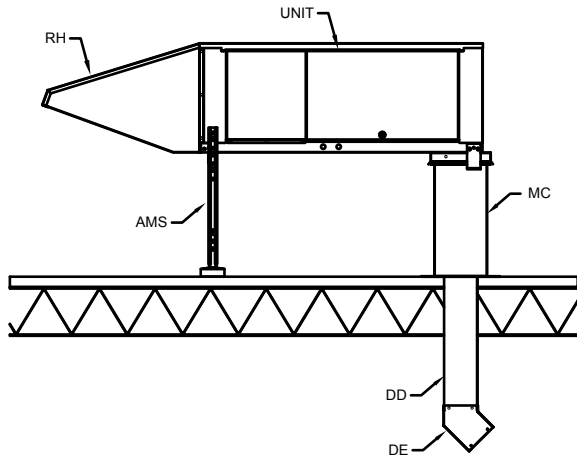
Field constructed intake accessories should be designed to minimize the entry of snow and rain.

IMPORTANT

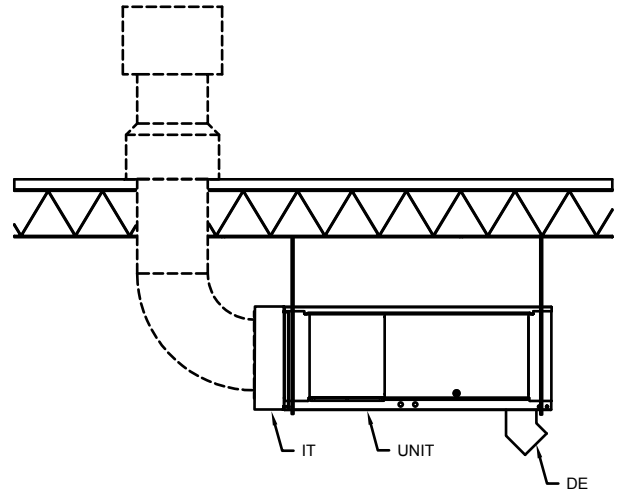
The minimum clearance from the face of the electrical control enclosure to surrounding grounded surfaces for service activities is 42". Adequate clearance of 42" for burner removal is also required. Access for installation is also recommended on the side of the unit opposite the control enclosure for a distance of 24".

TYPICAL SYSTEM OVERVIEW ACCESSORY IDENTIFICATION

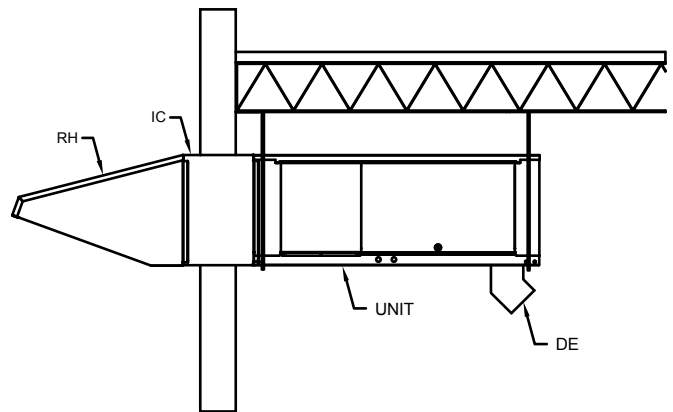
Roof Top Mounting



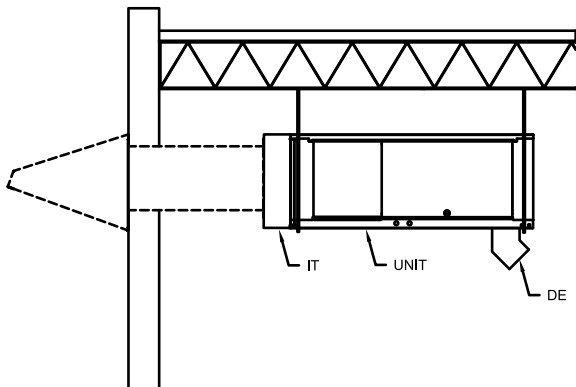
Under Roof Mounting



Thru Wall Mounting



Thru Wall - Spiral Mounting



Component Identification

AMS	Adjustable Mounting Stand
DD	Discharge Duct
DE	Directional Elbows
IC	Inlet Collar
IT	Inlet Transition
MC	Mounting Curb
RH	Rain Hood

TYPICAL SYSTEM OVERVIEW

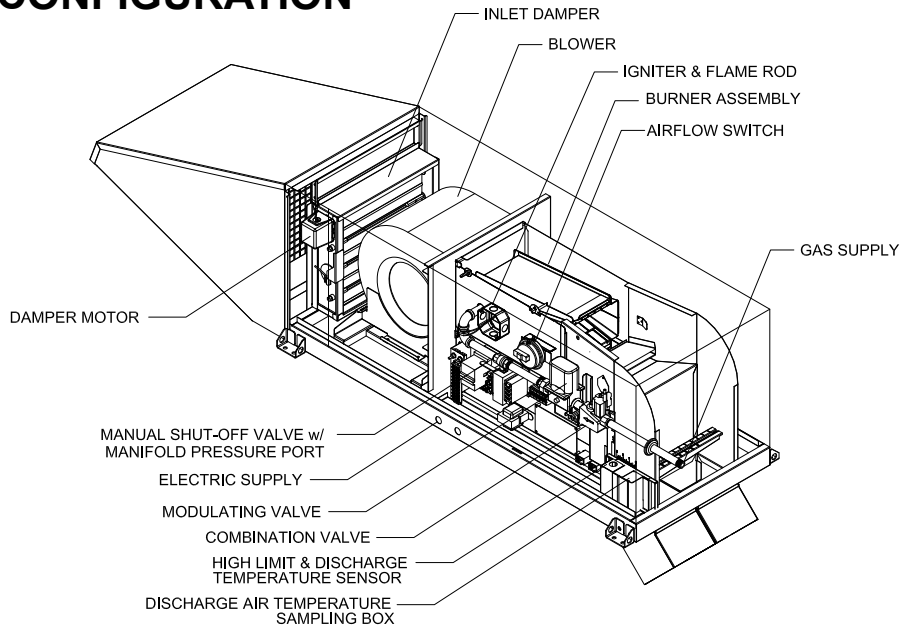
HEATER OPERATION

Cambridge SA-Series Blow-Thru® heaters are utilized to meet the space heating requirements of commercial or industrial buildings. The control system is typically designed to cycle the heaters on and off in response to the rise and fall of the space temperature. The heater will discharge air at the temperature selected (up to

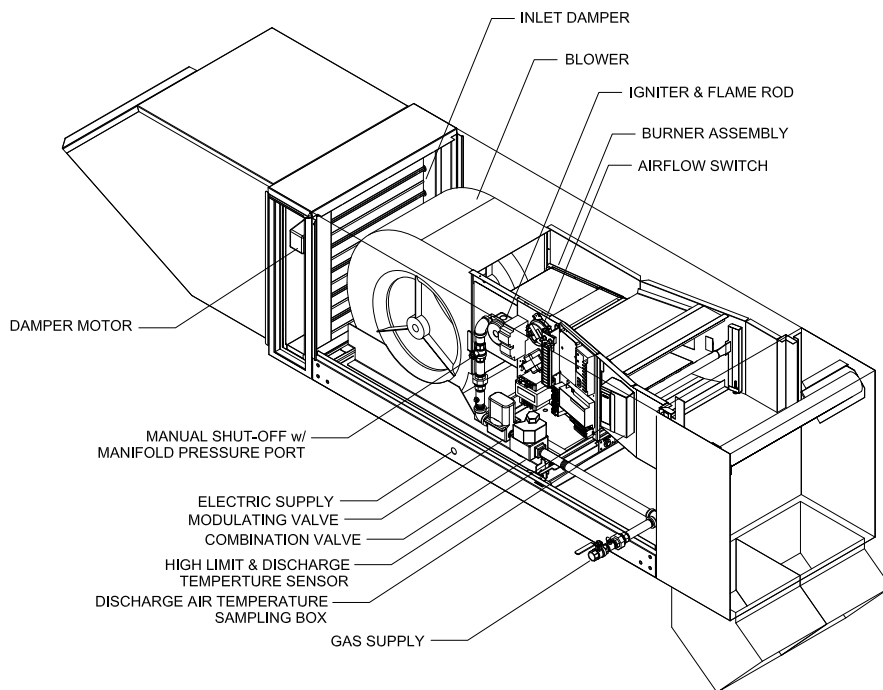
160°F). The operating thermostat is typically located near the perimeter of the building in a location which is out of the direct path of the heated discharge air, insulated from cold surfaces, and shielded from cold drafts created by air infiltrating the building.

HEATER CONFIGURATION

SA250



SA350



INSTALLATION INSTRUCTIONS

ROOF TOP MOUNTING

⚠ WARNING:

It is recommended the heater mounting structure be reviewed and approved by a qualified structural engineer and the roof manufacturer before installing this equipment.

IMPORTANT

Before proceeding with the installation, verify the feasibility of the location selected with respect to accessibility to the equipment for service and maintenance functions.

IMPORTANT

To minimize snow and rain ingestion, position the heater inlet opposite the prevailing winds.

IMPORTANT

To prevent contaminated air from being drawn into the heater, install the heater's inlet at least 10 feet from any building exhaust, process exhaust, sewer stacks, or other sources that would allow contaminants to be drawn into the heater. Consult local codes for additional references.

1. Prepare roof penetration to the dimensions below. Prepare gas and electric penetrations.

IMPORTANT

Accurate measurements are critical and will affect the installation process.

2. Secure the mounting curb and mounting stands per the structural engineer and roof manufacturer's recommendations.

IMPORTANT

The roof curb and mounting stands should be installed so that the heater will mount level. Cambridge recommends mounting the heater 24" off the roof surface in areas where snow accumulation could impact heater operations.

3. Lower the discharge duct through the mounting curb and the roof opening and secure the counterflashing to the mounting curb.
4. Use a crane or comparable lifting device to raise and position the equipment. Block the heater where necessary. Use a spreader bar to prevent damage and connect slings to the lifting brackets.

⚠ WARNING:

Do not attach lifting means to heater accessories. Make connections to heater only.

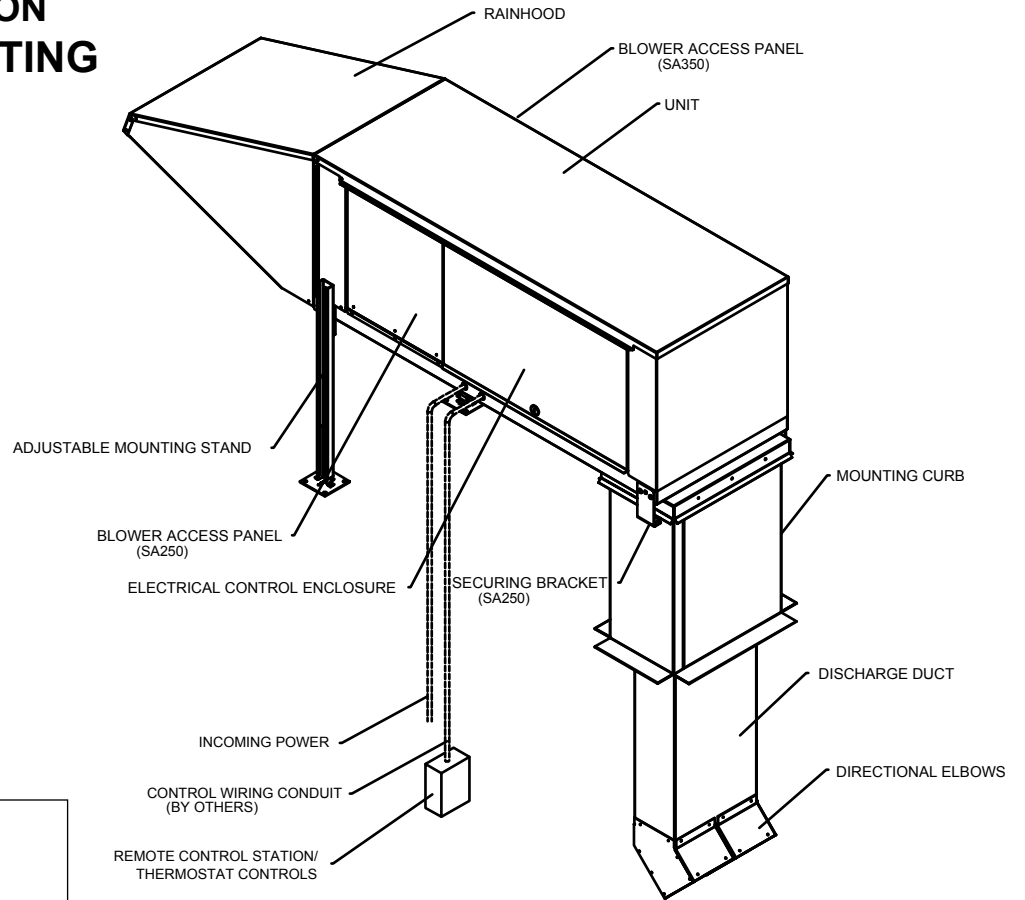
IMPORTANT

Inlet accessories may be attached on the ground or on the roof depending on the method chosen by the installer.

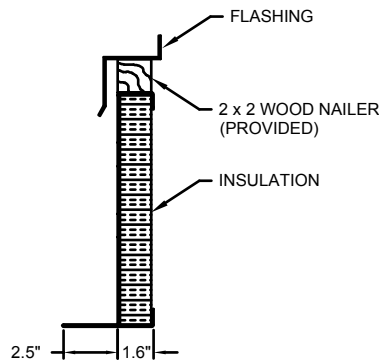
5. Using the adjustable mounting stand, lower the heater inlet slightly (1/8" below level) so that any ingested moisture will drain out of the heater and onto the roof surface.
6. Secure the unit to the mounting curb on both sides via the provided securing brackets.
7. Caulk all the joints between the heater and the accessories with silicone caulk to prevent water leaks.
8. Seal all roof penetrations to prevent roof leaks.
9. Install the directional elbows. Consult the job layout for the orientation of the elbows.

Model	Weight	A	B	Roof Opening	
				L	W
SA250	265 lbs.	48.25"	21.17"	8.5"	16"
SA350	550 lbs.	65.5"	25.5"	13"	25"

TYPICAL INSTALLATION ROOF TOP MOUNTING



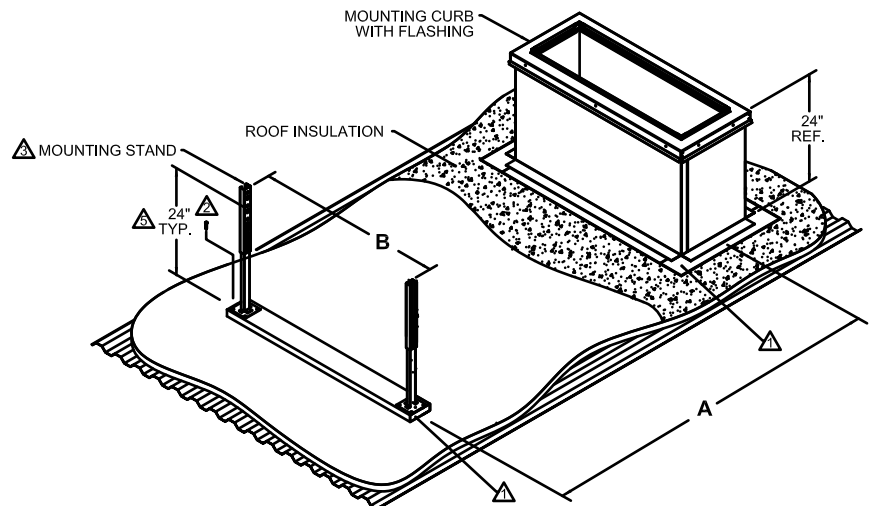
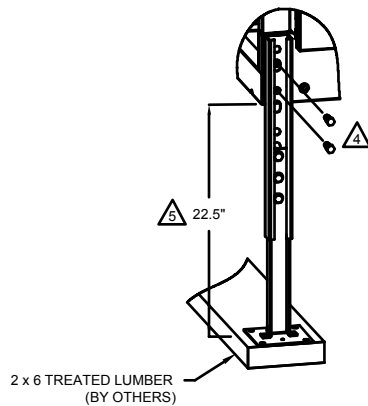
CURB SECTION



NOTES

- 1 TREATED TIMBER REQUIRED UNDER MOUNTING CURB AND STAND TO SECURE AND LEVEL UNIT.
- 2 SECURE MOUNTING STAND TO TIMBER WITH WOOD LAG SCREWS AS SHOWN.
- 3 MOUNTING STAND CONSTRUCTION: 12 GA. GALVANIZED STEEL
- 4 ATTACH MOUNTING STAND TO UNIT
- 5 ADJUSTABLE $\pm 3.75"$

STAND DETAIL



INSTALLATION INSTRUCTIONS THRU WALL MOUNTING

⚠ WARNING:

It is recommended the heater mounting structure be reviewed and approved by a qualified structural engineer and the roof manufacturer before installing this equipment.

IMPORTANT

Before proceeding with the installation, verify the feasibility of the location selected with respect to accessibility to the equipment for service and maintenance functions.

IMPORTANT

To prevent contaminated air from being drawn into the heater, install the heater's inlet at least 10 feet from any building exhaust, process exhaust, sewer stacks, or other sources that would allow contaminants to be drawn into the heater. Consult local codes for additional references.

1. **For square duct** - prepare wall penetration for inlet collar to the dimensions below.
For round duct - prepare wall penetration to accommodate the inlet duct (by others).
2. **For square duct** - Connect the inlet collar and the rain hood to the unit prior to lifting the heater in place.
For round duct - Attach the inlet duct to the rain hood. Lift the rain hood and inlet duct into place and attach to the wall.

3. Install hanging rods to adequate ceiling supports and align with the hanging brackets on the unit. Locate the hanging rods so that the weep holes provided in the rain hood are located a minimum of 3" beyond the outside wall surface.
4. Install the hanging brackets on the heater.
5. Use a forklift or comparable lifting device to raise and position the heater. Take precautions to prevent equipment damage (dents and/or scratches) when the heater is being lifted into position.
6. Use washers and double lock nuts to secure the unit on the hanging rods.
7. **For round duct** - Attach the inlet duct to the inlet transition.

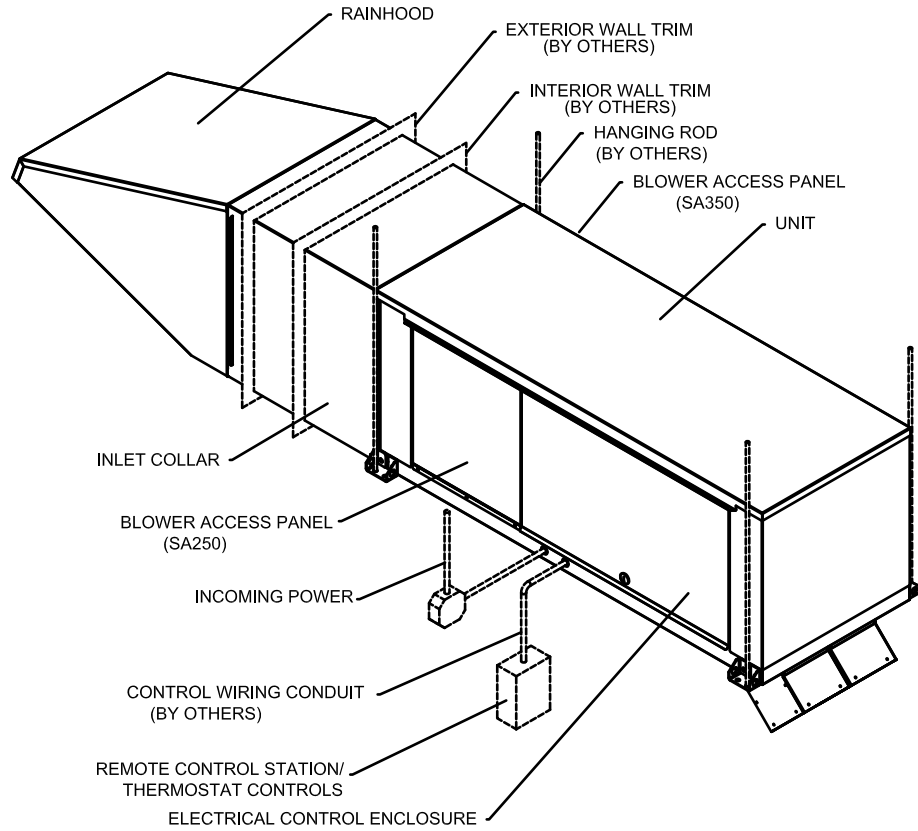
IMPORTANT

The discharge end of the heater should be raised slightly (1/8" above level) to slope the rain hood so any ingested moisture will run outside the building.

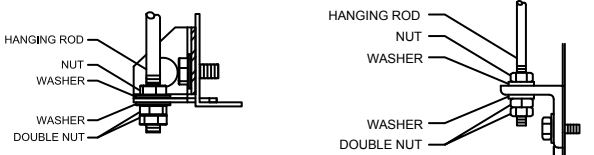
8. Install fiberglass insulation in the gaps around the wall opening. Apply enough material to accommodate the full thickness of the wall.
9. Install finish trim pieces (by others) to the top, sides and bottom of the wall opening on both the inside and outside wall surfaces.
10. Apply silicone caulk at the joint between the top of the rain hood and the outside wall surface. Make certain this is a continuous bead and that it runs the entire width of the rain hood. Caulk all other exposed joints.
11. Install the directional elbows. Consult the job layout for the orientation of the elbows.

Model	Weight	Hanging Rods				Wall Opening	
		Qty.	Size	A	B	H	W
SA250	220 lbs.	4	3/8" dia.	53"	23.16"	23"	23"
SA350	550 lbs.	4	3/8" dia.	58"	33.25"	25"	27.5"

TYPICAL INSTALLATION THRU WALL MOUNTING



HANGING BRACKET DETAIL

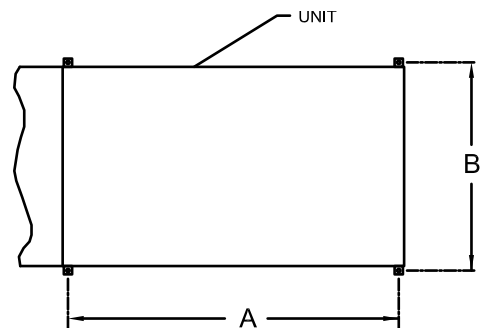


HANGING RODS, NUTS AND WASHERS BY OTHERS

SA250

SA350

HANGING ROD DETAIL



INSTALLATION INSTRUCTIONS UNDER ROOF MOUNTING

⚠ WARNING:

It is recommended the heater mounting structure be reviewed and approved by a qualified structural engineer and the roof manufacturer before installing this equipment.

IMPORTANT

Before proceeding with the installation, verify the feasibility of the location selected with respect to accessibility to the equipment for service and maintenance functions.

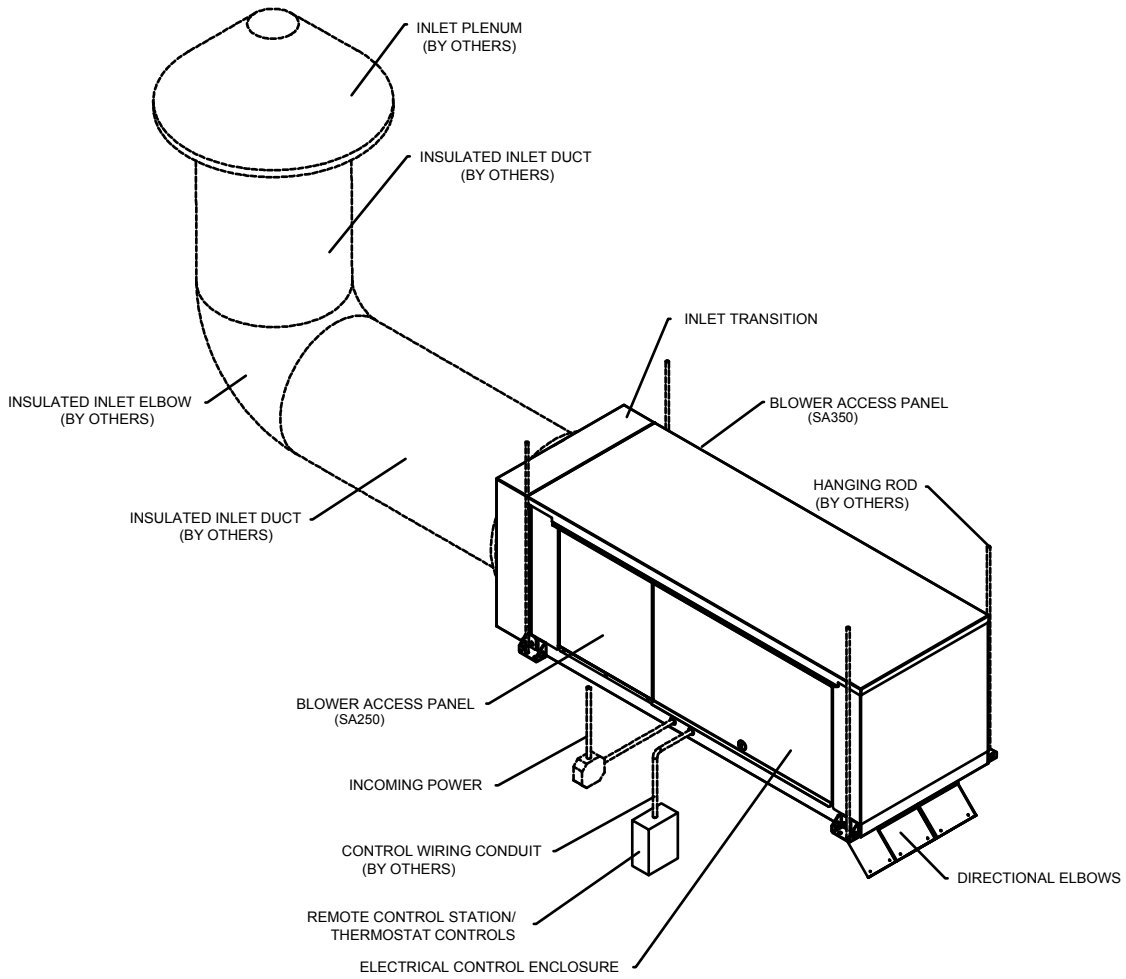
IMPORTANT

To prevent contaminated air from being drawn into the heater, install the heater's inlet at least 10 feet from any building exhaust, process exhaust, sewer stacks, or other sources that would allow contaminants to be drawn into the heater. Consult local codes for additional references.

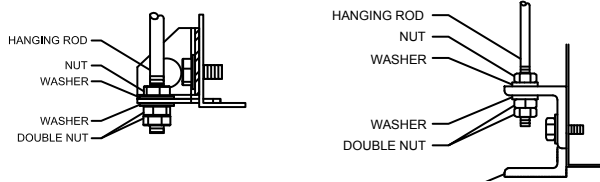
1. Install the accessories for roof intake (by others).
2. Install the hanging brackets on the heater.
3. Install hanging rods to adequate ceiling supports and align with the hanging brackets on the heater.
4. Use a forklift or comparable lifting device to raise and position the heater. Take precautions to prevent equipment damage (dents and/or scratches) when the heater is being lifted into position.
5. Use washers and double lock nuts to secure equipment on the hanging rods.
6. Install the directional elbows. Consult the job layout for the orientation of the elbows.

Model	Weight	Hanging Rods			
		Qty.	Size	A	B
SA250	220 lbs.	4	3/8" dia.	53"	23.16"
SA350	550 lbs.	4	3/8" dia.	58"	33.25"

TYPICAL INSTALLATION UNDER ROOF MOUNTING



HANGING BRACKET DETAIL

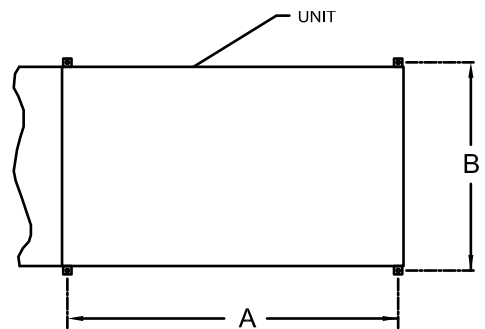


HANGING RODS, NUTS AND WASHERS BY OTHERS

SA250

SA350

HANGING ROD DETAIL



INSTALLATION INSTRUCTIONS

GAS PIPING

IMPORTANT

Refer to the heater nameplate for determining the minimum gas supply pressure for obtaining the maximum gas capacity for which this heater is specified.

1. Check with the local utility or gas supplier to determine the gas supply pressure.

CAUTION:

If the gas supply pressure is in excess of the maximum pressure indicated (14" WC) on the heater nameplate, a separate positive shutoff high pressure regulator must be added upstream of the heater's individual manual shutoff valve. This regulator must be vented to outside of building at least 10 feet from any intake opening. The vent pipe should be designed to prevent the entry of water, snow, insects or other foreign material that could cause blockage. There must be no reduction in size of the vent piping. Depending on the length and the configuration of the vent piping the pipe size may need to be increased. Refer to the applicable codes for proper sizing.

2. Properly size the gas supply piping for the rated input capacity, per local codes, and/or the National Fuel Gas Code, ANSI Standard Z223.1 or the CAN/CSA B149 Installation Codes.
3. Make sure the supply piping is free of foreign matter and purged.
4. Verify that the gas piping, when installed, will not restrict or block the unit access door from fully opening.
5. Install the gas piping to the unit in accordance with local codes or, in their absence, in accordance with the National Fuel Gas Code, ANSI Standard Z223.1 or the CAN/CSA B149 Installation Codes.

IMPORTANT

A 1/8" NPT tap is supplied with the heater for measuring the gas supply pressure. If the gas supply pressure exceeds that indicated on the nameplate, the installer must install a 1/8" NPT tap and high pressure manual shutoff valve upstream of the high gas pressure regulator.

CAUTION:

An adequate sediment trap must be installed upstream of all gas controls for the heater and as close to the gas inlet connection of the heater as practical.

NON-RECIRCULATING DIRECT INDUSTRIAL AIR HEATER			
ANSI Z223.1	OR	CSA 2.2	NON-RECIRCULATING DIRECT INDUSTRIAL AIR HEATER FOR INDUSTRIAL / COMMERCIAL USE
MINIMUM CLEARANCE TO COMBUSTIBLES:			
TOP	FRONT	REAR	BOTTOM
0 in.	0 in.	0 in.	0 in.
NOTE: ACCESS REQUIRED FOR SERVICE ACTIVITY MUST ON CONTROL ENCLOSURE SIDE AND (S4) ON OPPOSITE SIDE.			
MODEL NO.	SERIAL NO.		
THIS UNIT IS SPECIFICALLY DESIGNED FOR THE FOLLOWING OPERATING PARAMETERS:			
GAS TYPE <input type="checkbox"/> NAT. GAS <input type="checkbox"/> LP GAS			
MAX. INPUT RATE BTU/H	MAX. GAS SUPPLY PRESSURE (SEE THE SECTION OF THIS INPUT ADJUSTMENT)	IN. W.C.	
MIN. INPUT RATE BTU/H	MINIMUM OPERATIONAL PRESSURE (IN. W.C.)		
MAX. GAS SUPPLY PRESSURE <input type="checkbox"/> IN. W.C. <input type="checkbox"/> PSIG	MAX. OPERATING TEMPERATURE (°F)		
MIN. GAS SUPPLY PRESSURE (IN. W.C.) (SEE TECHNICAL PAGE S400)	MIN. TEMPERATURE RISE (°F)		
	MIN. AMBIENT TEMPERATURE (°F)	-30	
ELECTRICAL <input type="checkbox"/> VOLTS <input type="checkbox"/> PHASE <input type="checkbox"/> HERTZ <input type="checkbox"/> AMPERES <input type="checkbox"/> HP.			

IMPORTANT

Many gas train components are equipped with Listed Vent Limiters as atmospheric bleeds, however, local codes may require that these vents and bleeds be vented to the outdoors. If so, the vent piping should be designed to prevent the entry of water, snow, insects or other foreign materials that could cause blockage.

6. Apply test pressure to the supply piping system and check for leaks. Use liquid gas detector. Do not use flame.

CAUTION:

If the test pressure is in excess of 1/2 PSIG (3.45 KPA), the heater and its manual shutoff valve must be disconnected from the gas supply system during pressure testing. Failure to comply will void warranty.

If the test pressure is less than or equal to 1/2 PSIG (3.5 KPA), the heater must be isolated from the gas supply piping by closing its manual shutoff valve during pressure testing.

WARNING:

Do not attempt to start unit at this time. Premature start-up can result in damage to equipment and components.

INSTALLATION INSTRUCTIONS

ELECTRICAL WIRING

IMPORTANT

Before attempting electrical installation, review the following instructions and the wiring and connection diagrams to make sure you have a thorough understanding of the requirements.

⚠ WARNING:

High voltage electrical input to this equipment is required. Extreme caution should be exercised. This equipment must be electrically grounded in accordance with local codes or in accordance with National Electrical Code ANSI/NFPA No. 70 or the Canadian Electrical Code C22.1.

1. Check the heater nameplate to determine the voltage and amperage requirements.

IMPORTANT

Do not proceed with installation unless the supply voltage agrees with the nameplate voltage. If supply voltage does not agree with nameplate voltage, check with your local agent or Cambridge Air Solutions Customer Service Group at 1-800-473-4569 to determine what changes are required.

2. Install the supply wiring and adequate Branch Circuit Protection in accordance with National Electric Code ANSI/NFPA 70 or Canadian Electrical Code C22.1.
3. Mount the remote control station. This panel should be located inside of the building and convenient to the operator without being susceptible to damage.
4. Any temperature sensors should be located along a perimeter wall and out of the direct path of the discharge air or air infiltration. Consult the design drawing and/or Cambridge's Customer Service Group for placement assistance. Do not locate remote mounted temperature sensors immediately adjacent to overhead doors because infiltration air can affect the sensor when the door is closed and the sensor may not adequately sense the temperature when the door is open. In this application, the sensor should be located on the first column in from the outside wall.

⚠ CAUTION:

Observe special notes and instructions on Wiring and Connection Diagrams regarding sensor installation.

The wiring for any temperature sensors mounted remote from the remote control station must be shielded, twisted-pair wiring and must run separate from other AC wiring.

If the thermistor is not mounted remote from the remote control station, trim the excess wire length from the thermistor, as required.

Shielded wire which is routed to the heater's electrical control enclosure should extend beyond the high voltage section of the enclosure before the shielding is terminated and the wiring is distributed to its ultimate destination.

Shielding must be grounded at the remote control station end only.

5. Wire the remote control station and other temperature control options using Class II wiring per the Cambridge wiring diagram and National Electrical Code Article 725 or Canadian Electrical Code C22.1 section 16 or local codes.
6. Connect the supply wiring to an electric disconnect switch (by others) having adequate ampacity per National Electrical Code, Article 430, ANSI/NFPA 70 or Canadian Electrical Code C22.1 Sections 12 and 28. See the heater nameplate for voltage and ampacity requirements.

IMPORTANT

Power and control wiring inlets on all outdoor units must be sealed with silicone caulk to prevent moisture accumulation.

7. Return the wiring diagram to the manual holder. Replace and fasten all access covers.

⚠ WARNING:

Do not attempt to start unit at this time. Premature start-up can result in damage to equipment and components.

MOTOR AMP DRAW CHECK

IMPORTANT

The blower access door must be closed for this test.

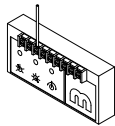
1. Turn the blower service switch to the "LOCAL" position and let the motor warm up.
2. Check motor current at the motor starter.
3. Turn the blower service switch to "OFF" position.

IMPORTANT

The motor current must not exceed 103% of the Motor Nameplate FLA. High amperage may indicate excessive blower RPM

BURNER MANIFOLD PRESSURE ADJUSTMENT

1. Turn off the disconnect switch (by others).
2. Remove the wire from terminal #3 on the amplifier. This will drive the modulating valve to full open.



3. Remove the 1/8" plug from the manual shut-off valve located just prior to the burner, and connect a manometer for the purpose of measuring the manifold pressure.
4. Refer to the heater nameplate for the Manifold Differential Pressure (MDP) and record in step 7.
5. Turn on the disconnect switch (by others).
6. Turn the blower service switch to the "LOCAL" position. The blower motor will start. Observe the pressure reading on the manometer and record in step 7. (Note whether the reading is positive or negative.)
7. Using the formula below, determine the required manifold pressure reading for the manometer.

Nameplate MDP _____ " WC

Manifold Static Pressure
(Blower Only) + _____ " WC

Manifold Pressure Reading = _____ " WC

IMPORTANT

A negative manifold static (blower only) will cause the manifold pressure reading to be lower than the nameplate manifold differential pressure.

8. Turn the burner service switch to the "LOCAL" position. After a delay for prepurge and igniter warm-up, the burner will light. Allow 15 seconds for the low fire start to time out.
9. Observe the manometer reading and compare to the manifold pressure determined (Step 7). If the manifold pressure reading does not equal this value, adjust the control regulator until the proper manifold pressure is obtained.
10. Turn the blower and burner service switches to the "OFF" position.
11. Reconnect the wire to terminal #3 on the amplifier.

MINIMUM FIRE ADJUSTMENT

The minimum fire setting is preset at the factory at approximately 20°F rise.

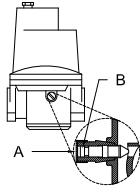
IMPORTANT

A DC microammeter is required to monitor flame signal during the adjustment procedure. Ensure the flame signal remains steady and of sufficient strength to maintain burner operation for both consistent ignition at minimum fire and locking in the flame safeguard relay. Do not allow the flame signal to drop below 2.0 microamps DC.

1. Remove the cover of the Discharge Air Temperature Sampling Box. Refer to the Heater Configuration (page 5) for the Discharge Air Temperature Box location, and the Individual Component Description Section (page 39) for additional information. Install a thermocouple in the grommet inside the Discharge Air Temperature Sampling Box, and then reinstall the cover. Route the thermocouple wire to a meter located outside of the unit.
2. Turn the blower service switch to the "LOCAL" position and monitor the discharge temperature.
3. Remove the wire from terminal #8 on the amplifier. This will cause the burner to light on low fire and then fall to minimum fire.
4. Turn the burner service switch to the "LOCAL" position. After a delay for prepurge and igniter

warm-up, the burner will light. Allow 15 seconds for the low fire start to time out.

5. Monitor the discharge temperature and flame signal. Subtract temperature from step 1 above from this reading to determine temperature rise. If minimum fire temperature rise is above 20°F and flame signal is above 2.0 microamps DC, proceed to step 7.
6. Remove the cap (A) exposing the minimum fire adjusting screw. Turn the adjusting screw (B) to obtain the desired minimum fire setting.



7. Replace the cap (A).
8. Turn blower and burner service switches to the “OFF” position.
9. Reconnect the wire to terminal #8 on the amplifier.
10. When performing start-up proceed to next step, otherwise perform Final Heater Preparation (page 17).

CALIBRATION CHECK

The discharge temperature control system has been calibrated at the factory to the specified airflow, static pressure, and temperature rise. The actual operating conditions may require minor adjustments to the control settings to ensure the heater functions within the operating parameters of its listing.

1. Remove the cover of the Discharge Air Temperature Sampling Box. Refer to the Heater Configuration (page 5) for the Discharge Air Temperature Box location, and the Individual Component Description Section (page 39) for additional information. Install a thermocouple in the grommet inside the Discharge Air Temperature Sampling Box, and then reinstall the cover. Route the thermocouple wire to a meter located outside of the unit.
2. The discharge temperature should match the temperature shown on the MAX dial located on the amplifier with a resistor of $7,500 \pm 250 \Omega$ connected between terminals 21 and 22. The dial should be set to 160°F.

IMPORTANT

The heater access doors must be closed for the remaining portion of this test.

3. Turn the blower and burner service switches to the “LOCAL” position. After a delay for prepurge and igniter warm-up, the burner will light. Allow 15 seconds for the low fire start to time out.
4. Monitor the discharge temperature until it stabilizes. Do not rush through this step.
5. The discharge temperature should be $160 \pm 5^\circ\text{F}$. If the discharge temperature complies with this requirement, no calibration is required. If the discharge temperature does not equal the expected value, proceed to Calibration Procedure (page 17).
6. For CE-Smart™ Controls remove the resistor on terminals 21 and 22 and connect the Space Temperature Selector (STS).
7. When performing a start-up proceed to the next step, otherwise perform Final Heater Preparation (page 17).

GAS VALVE LEAK CHECK

All heaters should be evaluated for the gas tightness of the gas valve seat. This evaluation must be performed at least once per year.

1. Connect a 0 to 10 inches water column (" WC) manometer to the 1/8" NPT tapped fitting directly before the manual shut-off valve located just prior to the burner for the purpose of monitoring an increase in pressure, and verify the manometer is properly zeroed.
2. Close the manual burner shut-off valve and, with supply gas connected, wait 30 seconds to read the manometer. If reading is greater than 0" WC, replace the gas valve and retest. If reading is 0" WC, remove manometer and install pipe plug.
3. When performing start-up proceed to next step, otherwise perform Final Heater Preparation (page 17).

GAS TRAIN LEAK CHECK

1. Remove the wire from terminal #3 on the amplifier. This will drive the modulating valve to full open.
2. Turn the blower service switch to the “LOCAL” position. Blower motor will start after the motorized damper (optional) opens.

- Turn the burner service switch to the “LOCAL” position. After a delay for prepurge and igniter warm-up, the burner will light. Allow 15 seconds for the low fire start to time out.

CAUTION:
Do not allow leak detector solution to come in contact with electrical components.

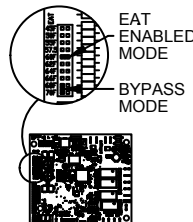
- With the burner operating, spray the complete gas train with leak detector solution, checking all pipe connections and plugs.

⚠ WARNING:
Any gas leak detected must be repaired before unit is placed into service.

- Turn the blower and burner service switches to the “OFF” position.
- Reconnect the wire to terminal #3 on the amplifier
- When performing start-up proceed to next step, otherwise perform Final Heater Preparation (page 17).

REMOTE CONTROL CHECK

- If the ambient temperature is at or above the Entering Air Thermostat (EAT) setpoint, note the setpoint position. Pull the jumper off the temperature setpoint (Normal Mode) and reinstall it sideways on the terminal block (Bypass Mode) as shown below. Refer to the Individual Component Description section for additional information.



- Turn the blower and burner service switches to the “REMOTE” position.
- On the thermostat, activate a call for heat by raising the heat temperature set point to the highest possible value.
- After a short delay for damper (optional) operation, the blower should operate, followed by burner ignition after a delay for pre-purge and igniter warm-up.
- Reset the thermostat to the desired space temperature.

- Reinstall jumper to (Normal Mode).
- Service switches should be in "REMOTE".

FINAL HEATER PREPARATION

- Perform visual inspection of all wiring and gas valve plugs to ensure they have been properly replaced.
- Remove all test instrumentation.
- Replace and fasten all covers and panels. Close the control enclosure and latch the door.
- Turn on the disconnect switch (by others).

IMPORTANT

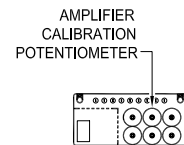
If technical assistance is needed, call the Cambridge Customer Service Group at 1-800-473-4569 during the hours of 8:00 a.m. to 5:00 p.m. Central Time, Monday through Friday.

SHUTDOWN INSTRUCTIONS

- Turn mode selector switch to “OFF” position.

CALIBRATION PROCEDURE

- Remove the two mounting screws from the Maxitrol A1044 Amplifier located in the Electrical Control Enclosure. Refer to the Electrical Control Enclosure Isometric Drawing (page 35) for additional information.
- Turn the amplifier over and adjust the amplifier calibration potentiometer shown in the drawing. To raise the discharge temperature, use a Phillips screwdriver to adjust the potentiometer counter clockwise. To lower the discharge temperature, adjust the potentiometer clockwise.



- Wait for the discharge temperature and manifold pressure to stabilize after making adjustments. Do not rush this step.
- In rare cases, the amplifier calibration potentiometer will reach its adjustment limit before the proper discharge temperature is achieved. If this occurs, the Discharge Temperature Sensor (DTS) will need to be adjusted:

- a. Turn the burner service switch to the “OFF” position and allow the Discharge Air Temperature Sampling Box time to cool.
- b. Turn blower service switch to “OFF” position.
- c. Open the control enclosure door.
- d. Remove the access cover from the Discharge Air Temperature Sampling Box and remove the two mounting screws from the DTS. Refer to the Individual Component Description Section (page 38-40) for additional information.
- e. Carefully remove the DTS from the sampling box, turn it over and adjust the DTS calibration potentiometer shown in the drawing. To raise the discharge temperature, adjust the potentiometer 90° counterclockwise.



- f. Carefully reinstall the DTS. Replace the Discharge Air Temperature Sampling Box cover, and close the unit access doors.
- g. Turn the blower and burner service switches to the “LOCAL” position. After a delay for the prepurge and igniter warm-up, the burner will light.
- h. Wait for the discharge temperature and manifold pressure to stabilize. Do not rush this step.
- i. Repeat steps 2 through 4 until manifold pressure and discharge temperature comply with guidelines of Calibration Check procedure step 5 (page 16).
- j. Reinstall the amplifier that was removed in step 1.

MAINTENANCE INSTRUCTIONS

BELT TENSIONING (SA350 ONLY)

Using a Browning Belt Tension Checker and a straight edge, verify proper belt tension to a center span deflection of 1/4" for 2-3 lbs. for new belts or 1-2 lbs. for used belts.

Periodic belt adjustments may be required. Indications of loose belts include barking or squealing when blower starts.

BLOWER CLEANING

The blower wheel should be examined for accumulation of dust on the blades. These surfaces must be kept clean. Dirt accumulation will result in significant air flow reduction and/or possible imbalance of the blower wheel.

⚠ CAUTION:

Prolonged imbalance can result in catastrophic failure of the blower wheel and other related components.

BURNER CLEANING

The Cambridge Air Solutions burner is for the most part self-cleaning. However, if the application is extremely dirty or dusty, it may become necessary to periodically clean the burner. Remove and clean the burner in accordance with the following recommended procedures:

1. Turn off the disconnect switch (by others). Close the manual gas supply shut-off valve.
2. Loosen the union in the gas train.
3. Disconnect the ignition cable from the burner and remove the flame rod and the igniter.
4. Examine the flame rod ceramic for cracks and replace if necessary. Clean the flame rod element with emery cloth to remove oxidation.
5. Remove fasteners that secure burner to housing. The burner will then be free to slide out.
6. Clean burner by back-flushing using high pressure air (40-80 PSI). Continue back flushing until dust particles are completely expelled from burner.
7. Reinstall burner using above steps in reverse order.

GAS TRAIN LEAK CHECK

Periodically check the gas control assembly, internal and external piping for leaks. Refer to the Gas Train Leak Check procedure (page 16). All relief vents on the gas controls should be checked for blockage (gas pressure regulators and pressure switches).

OPERATING INSTRUCTIONS

OPERATING SEQUENCE

POWER ON

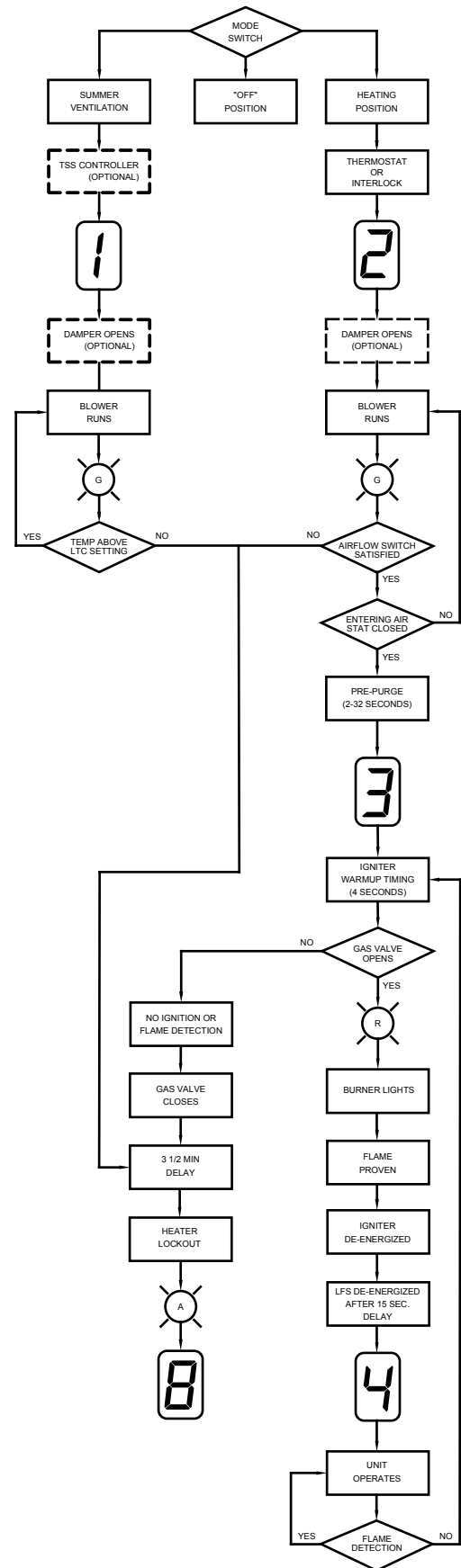
1. Control transformer energized.
2. Operator must select “SUMMER VENTILATION” or “HEATING” mode. (CE-Smart only)

SUMMER VENTILATION MODE (CE-Smart™ only)

1. Mode switch in “SUMMER VENTILATION” position.
2. TSS Controller schedule calls for ventilation.
3. Optional motorized inlet damper opens.
4. Blower motor starts.
5. Unit continues to run until turned off.

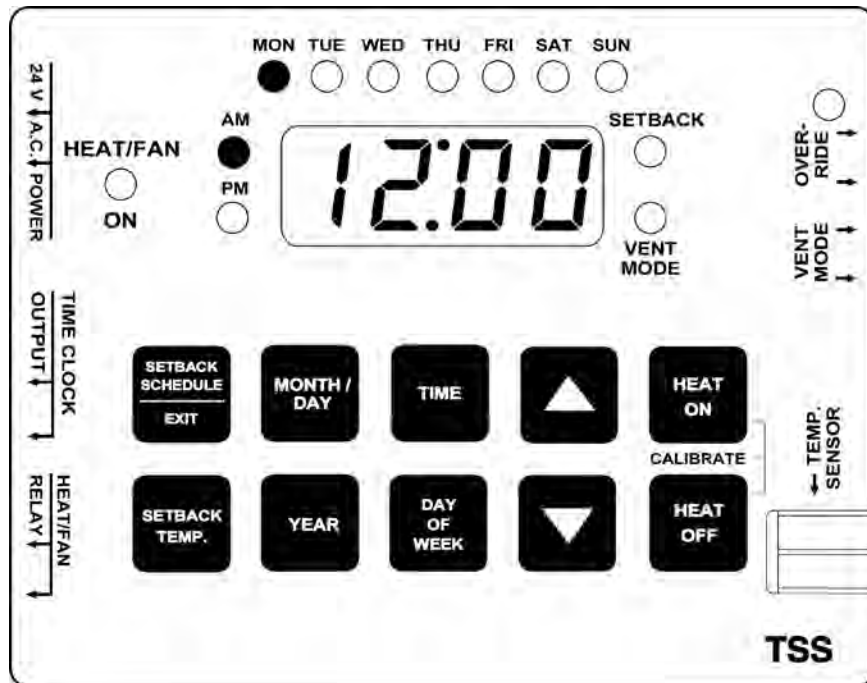
HEATING MODE

1. Mode switch in “HEATING” position. (CE-Smart only)
2. Thermostat or interlock calls for heat.
3. Optional motorized inlet damper opens.
4. Blower motor starts.
5. Airflow switch closes.
6. Entering air thermostat closes when inlet temperature is below setpoint after the pre-purge delay.
7. Igniter warm up timing.
8. Gas valve opens.
9. Burner lights.
10. Igniter is de-energized.
11. Low Fire Start is de-energized after 15 seconds.
12. Unit runs and modulates until operating thermostat and/or interlock opens (heater shuts off).
13. Steps (2) through (12) repeat themselves automatically as necessary.



OPERATING INSTRUCTIONS

TSS CONTROLLER



The Cambridge Air Solutions TSS Controller provides several features to tailor the operation of the Cambridge heating system to particular applications.

- Seven day programmable clock.
- Separate temperature settings for Heating and Setback operation.
- Separate schedules for Summer Ventilation and Heating modes.
- Setback Override for temporary heating operation.
- Real-Time Clock with automatic adjustment for Daylight Saving Time.
- Nine Holiday Setback Periods for temporary setback operation.
- Temperature Calibration for accurate temperature control.
- Capacitor backup maintains current time and day of week for power loss of up to 96 hours.
- EEPROM storage maintains schedules and temperature settings indefinitely.

The thermistor enclosure (SH-1) is packed inside the Remote Control Station for shipment. It can be mounted on the exterior sides or bottom of the Remote Control Station or a remote location within 500 feet of the Remote Control Station using 18 gauge stranded, twisted-pair, shielded cable. The thermistor is hard wired to the temperature sensor terminal block.

SETTING CURRENT DAY OF WEEK, TIME, MONTH/DAY, AND YEAR

For proper operation of the scheduler, the TSS Controller clock must be set to the correct day of week, time, month/day and year. In the event of power loss of more than 96 hours, these settings must be updated.

During normal operation, the TSS Controller display will alternate between the current space temperature and the current time and day of the week.

1. Press and hold the **DAY OF WEEK** button while pressing the **UP** or the **DOWN** button until the light for the current day is illuminated.



2. Press and hold the **TIME** button while pressing the **UP** or the **DOWN** button until the current time is displayed.



3. Press and hold the **MONTH/DAY** button while pressing the **UP** or the **DOWN** button until the current date is displayed.



4. Press and hold the **YEAR** button while pressing the **UP** or the **DOWN** button until the current year is displayed.

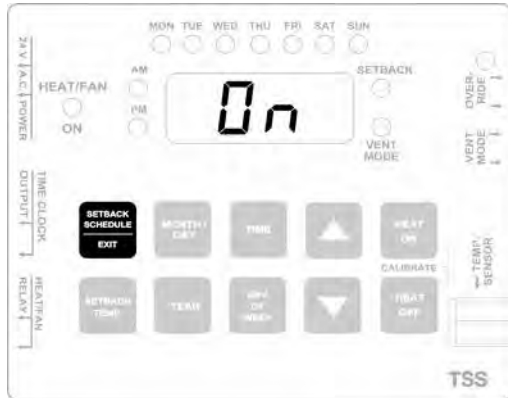


SETTING AUTOMATIC ADJUSTMENT FOR DAYLIGHT SAVING TIME

The TSS Controller has the ability to automatically detect and adjust for daylight saving time. The default setting on the controller is to recognize daylight saving time.

SETTING TEMPERATURES

1. Press the **SETBACK SCHEDULE/EXIT** button to enter the scheduling program at the first ON cycle.



2. Press the **UP** button once to enter the daylight saving time setting ("d-SA" is displayed).



3. Press and hold the **YEAR** button while pressing the **UP** or the **DOWN** button to scroll to "YES" if daylight saving time should be recognized or "NO" if daylight saving time is not recognized.



4. Press the **SETBACK SCHEDULE/EXIT** button to exit the scheduling program.

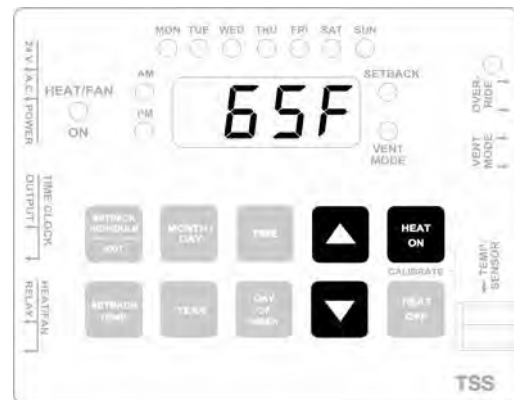
The TSS Controller has two temperature control modes with the keyswitch on the front of the enclosure in the HEATING position. The HEATING mode controls the heater when the ON time schedule is in effect. The SETBACK mode controls the heater when the OFF time schedule is in effect. (See SETTING SCHEDULES for instructions on setting the ON and OFF schedules). With the keyswitch in the SUMMER VENTILATION position the heater fan will run based on the time schedule with no temperature control.

HEATING MODE (ON Time Schedule)

The HEATING mode requires two temperature settings. When the temperature drops below the HEAT ON setting the heater will turn on. When the heater raises the space temperature above the HEAT OFF setting, the heater will turn off. This difference provides an adjustable range of operation for the heater, which minimizes temperature swings. The minimum on time and off time for the heater regardless of temperature is 2 minutes. The allowable temperature range is 41°F to 99°F.

The HEAT OFF temperature cannot be set lower than the HEAT ON temperature.

1. Press and hold the **HEAT ON** button while pressing the **UP** or the **DOWN** button until the desired temperature for the heater to turn ON is displayed.



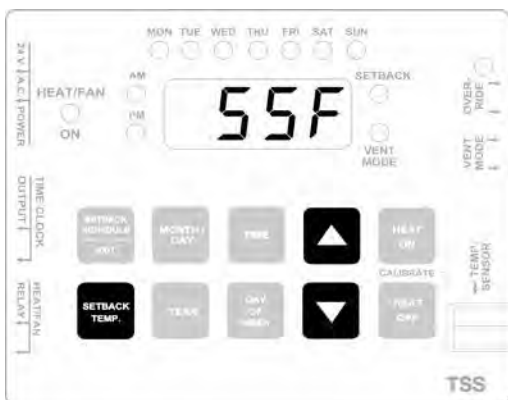
- Press and hold the **HEAT OFF** button while pressing the **UP** or the **DOWN** button until the desired temperature for the heater to turn OFF is displayed.



SETBACK MODE (OFF Time Schedule)

The SETBACK mode requires setting only the ON temperature. The OFF temperature will be automatically set based on the temperature difference between HEAT ON and HEAT OFF programmed above for the HEAT mode.

- Press and hold the **SETBACK TEMP.** button while pressing the **UP** or the **DOWN** button until the desired temperature for the heater to turn ON is displayed.



SETBACK OVERRIDE

In instances where temporary heat is desired when the scheduler is in the SETBACK mode, the OVERRIDE timer can be used. Setting this timer, located on the front of the TSS panel, will override the SETBACK temperature setting and increase the space temperature to the HEAT ON and HEAT OFF temperature settings for the amount of time set on the OVERRIDE timer.

SETTING SCHEDULES

The TSS Controller has separate programmable daily schedules for the HEATING and the SUMMER VENTILATION modes. The schedule currently in effect is determined by the position of the keyswitch in the door of the enclosure. With the keyswitch in the HEATING or OFF position, the schedule for the Heating Mode is accessible. With the keyswitch in the SUMMER VENTILATION position, the schedule for the Ventilation Mode is accessible. (This will be indicated by the VENT MODE light on the TSS Controller being illuminated). Before attempting to program the schedule, determine the planned time periods for HEAT (ON) and SETBACK (OFF) for the HEATING mode and the planned ON and OFF time periods for the Ventilation mode. The time that it takes to recover from the SETBACK temperature to the HEAT temperature must also be taken into consideration for the ON time in the HEATING mode. The following charts can be filled in for a reference during the programming of the schedule. There are fifteen available ON and OFF program cycles for both HEATING and SUMMER VENTILATION. The first ON and OFF cycles are fixed for Monday through Friday and should only be used when the schedules for those days are identical. The fourteen additional numbered cycles can be programmed for any one day or successive days.

NOTE: Do not program the TSS controller with overlapping schedules, as operational errors will occur. Whenever the heater is operating during a scheduled ON cycle and a subsequent overlapping program is encountered, that program will be ignored.

A Holiday Setback Schedule is available for temporary operation in the Setback Mode of up to nine different holiday periods without affecting the current schedules. (See HOLIDAY SETBACK SCHEDULE section for instructions on using this feature).

All unused program cycles should not contain any settings. Check all cycles after programming to assure that the display for unused cycles shows "--:--". If undesired settings have been entered, scroll the time display until "--:--" is displayed (between 11.59PM and 12.00AM for time settings; between 12.31 and 1.01 for date settings).

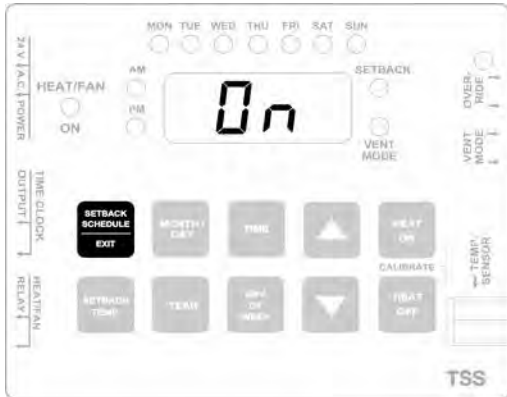
HEATING SCHEDULE

Cycle	Time	AM/PM	Day
On			M-F
Off			M-F
On 1			
Off 1			
On 2			
Off 2			
On 3			
Off 3			
On 4			
Off 4			
On 5			
Off 5			
On 6			
Off 6			
On 7			
Off 7			
On 8			
Off 8			
On 9			
Off 9			
On 10			
Off 10			
On 11			
Off 11			
On 12			
Off 12			
On 13			
Off 13			
On 14			
Off 14			

SUMMER VENTILATION SCHEDULE

Cycle	Time	AM/PM	Day
On			M-F
Off			M-F
On 1			
Off 1			
On 2			
Off 2			
On 3			
Off 3			
On 4			
Off 4			
On 5			
Off 5			
On 6			
Off 6			
On 7			
Off 7			
On 8			
Off 8			
On 9			
Off 9			
On 10			
Off 10			
On 11			
Off 11			
On 12			
Off 12			
On 13			
Off 13			
On 14			
Off 14			

1. Switch the keyswitch on the front of the enclosure to the desired operating mode. Allow ten seconds before proceeding.
2. Press the **SETBACK SCHEDULE/EXIT** button to enter the scheduling program at the first ON cycle.



3. Press and bold the **TIME** button while pressing the **UP** or the **DOWN** button to scroll to the desired ON time for Monday through Friday.



4. Press the **UP** button once to step to the first OFF cycle.



5. Press and bold the **TIME** button while pressing the **UP** or the **DOWN** button to scroll to the desired OFF time for Monday through Friday.



6. If **Monday through Friday** is the only schedule required, proceed to **Step 14**. If any additional programming is required, proceed with the following steps. Remember that subsequent program cycles must not overlap with the ON and OFF times set above.

7. Press the **UP** button once to step to the next ON cycle.



8. Press and bold the **TIME** button while pressing the **UP** or the **DOWN** button to scroll to the desired ON time.

9. Press and bold the **DAY OF WEEK** button while pressing the **UP** or the **DOWN** button until the light for the desired day is illuminated.

- Press the **UP** button once to step to the next OFF cycle.



- Press and hold the **TIME** button while pressing the **UP** or the **DOWN** button to scroll to the desired OFF time.
- Press and hold the **DAY OF WEEK** button while pressing the **UP** or the **DOWN** button until the light for the desired day is illuminated.
- Repeat steps 7-12 until all required program cycles have been entered.
- Press the **SETBACK SCHEDULE/EXIT** button to exit the scheduling program.
- Verify that the correct current time and light for day of the week are still displayed.

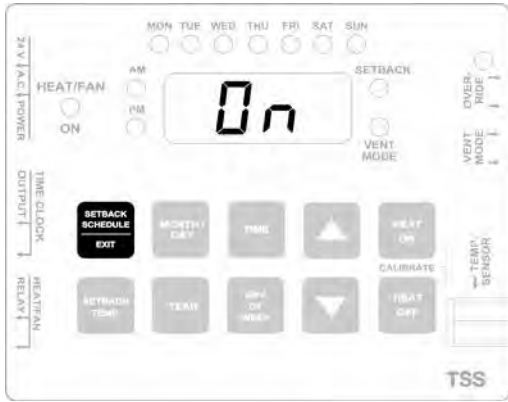
HOLIDAY SETBACK SCHEDULE

The Holiday Setback Schedule overrides the normal schedule and holds the space at the SETBACK temperature. The TSS Controller allows up to nine holiday periods (Holiday Start Date [HSD] and Holiday End Date [HED]) to be scheduled.

HOLIDAY SETBACK SCHEDULE

Cycle	Date
HSD 1	
HED 1	
HSD 2	
HED 2	
HSD 3	
HED 3	
HSD 4	
HED 4	
HSD 5	
HED 5	
HSD 6	
HED 6	
HSD 7	
HED 7	
HSD 8	
HED 8	
HSD 9	
HED 9	

1. Press the **SETBACK SCHEDULE/EXIT** button to enter the scheduling program at the first ON cycle.



2. Press the **UP** button repeatedly to step to the first holiday start date (HSd1).



3. Press and hold the **MONTH/DAY** button while pressing the **UP** or the **DOWN** button to scroll to the desired holiday start date.



4. Press the **UP** button once to step to the first holiday end date cycle (HEd1).



5. Press and hold the **MONTH/DAY** button while pressing the **UP** or the **DOWN** button to scroll to the desired holiday end date. (NOTE: Holiday end date must be at least one day after holiday start date).



6. Repeat steps 2-5 until all required holiday cycles have been entered.
7. Press the **SETBACK SCHEDULE/EXIT** button to exit the scheduling program.

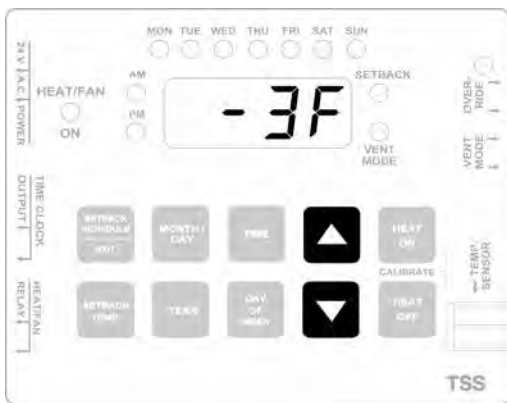
TEMPERATURE CALIBRATION

To compensate for lead wire resistance, it may be necessary to make an adjustment to the displayed temperature to correct it to the temperature measured at the thermistor sensor. The calibration feature allows the displayed temperature to be offset either above or below the actual sensed temperature. Be sure to use an accurate temperature meter for making this correction.

1. Press and hold the **HEAT ON** and **HEAT OFF** buttons while pressing the **UP** or the **DOWN** button until the correct temperature is displayed. (A period [.] after the F will indicate the Calibration Mode).



2. Pressing the **UP** or the **DOWN** button will display the current calibration difference above or below (-) the measured temperature.



TROUBLESHOOTING INSTRUCTIONS

TROUBLESHOOTING GUIDE

Problem	Possible Cause	Corrective Action
I. No Blower Operation (Continued on next page)	1. Unit in Reset a) Outside temperature below LTC setpoint in Vent Mode b) Gas valve not energized during call for heat cycle	a) Turn unit OFF momentarily and turn unit ON b) See Problem III
	2. Heater Power a) Disconnect in OFF position	a) Turn disconnect ON
	3. Mode Selector Switch (CE-Smart™) a) Switch in OFF position b) Defective switch	a) Place switch in proper mode b) Replace switch
	4. Operating Thermostat a) Thermostat satisfied b) Open in thermistor circuit c) Defective thermostat	a) Adjust thermostat, if applicable b) Check wiring or replace thermistor c) Replace thermostat
	5. Blower Service Switch a) Switch in OFF position b) Defective switch	a) Place switch in REMOTE position b) Replace switch
	6. Control Transformer a) No input voltage b) Blown control fuse c) Defective transformer	a) Check disconnect and supply fusing b) Replace control fuse c) Replace transformer
	7. Class II Transformer a) No output voltage b) Defective transformer	a) Check supply voltage b) Replace transformer
	8. Multi-Functional PC Board a) No input voltage on Terminal G (RCS) b) Improper wiring c) Defective board	a) Check voltage in RCS b) Check wiring c) Replace multi-functional PC board
	9. Inlet Damper (optional) a) Defective end switch b) Defective damper motor	a) Replace damper assembly b) Replace damper assembly
	10. Motor Starter a) Coil open (Defective)	a) Replace starter
	11. Motor Protection a) Overload tripped b) Overload defective	a1) Check primary power source a2) Allow motor to cool (SA250) Reset overload relay (SA350) a3) Check motor amps a4) Check overload setting (SA350) b) Replace motor (SA250) Replace overload relay (SA350)
	12. Motor a) No input voltage b) Improper voltage c) Defective motor	a) Check primary power source b) Consult factory c) Replace motor
	13. Blower a) Defective or locked bearings b) Physical damage	a) Replace or repair blower (SA250) Replace bearings (SA350) b) Replace or repair blower

TROUBLESHOOTING INSTRUCTIONS

TROUBLESHOOTING GUIDE

Problem	Possible Cause	Corrective Action
I. No Blower Operation (Continued)	14. Belts a) Belt Slipping b) Belt broken or missing	a) Tighten belts. b) Replace belts
II. BLOWER RUNS; NO HEAT; FLAME SAFETY RELAY DOESN'T LOCK OUT	1. Mode Selector Switch (CE-Smart™) a) Switch in VENT position b) Defective Switch	a) Place switch in HEAT position b) Replace switch
	2. Burner Service Switch a) Switch in OFF position b) Defective switch	a) Place switch in REMOTE position b) Replace switch
	3. Multi-Functional PC Board a) No input voltage on Terminal W (RCS) b) Inlet temperature above EAT setpoint c) Improper wiring d) Defective board	a) Check voltage in RCS b) Adjust EAT setpoint c) Check wiring d) Replace multi-functional PC board
	4. Airflow Switch a) Blower running backwards (SA350) b) Belts slipping (SA350) c) Blocked intake or discharge d) Clogged airflow tubing or pickup ports e) Defective switch	a) Reverse motor direction (SA350) b) Tighten and/or replace belts (SA350) c) Find and remove obstruction d) Clean or replace tubing or pickup ports e) Replace switch
	5. Flame Safeguard Relay a) No input voltage b) Defective FSR	a) Check wiring b) Replace FSR
III. BLOWER RUNS; NO HEAT; FLAME SAFETY RELAY LOCKS OUT	1. Igniter a) No current (open igniter) b) No voltage	During trial for ignition: a) Check igniter current b) Check FSR output to igniter
	2. High Limit a) High limit tripped	a) See Problem Number VI (page 32)
	3. Gas Valve a) No input voltage b) Gas valve does not open c) Defective solenoid	a1) Check FSR output to R1 relay during ignition trial a2) Check gas valve circuit and wiring b1) Compare supply to nameplate voltage b2) Clean and/or replace gas valve parts c) Replace solenoid or valve assembly
	4. Modulating Valve a) Minimum fire set too low	a) Adjust minimum fire on modulating valve
	5. Multi-Functional PC Board a) Low fire start set too low b) Thermistor open or not connected (rapidly blinking LED on PC board indicates open or shorted thermistor input)	a) Adjust modulating valve voltage between 10 and 13 Volts DC b) Properly install or replace thermistor
	6. Combination Valve a) Clogged vent orifice b) No supply pressure c) Improper manifold pressure d) Defective regulator	a) Clean or replace orifice b) Check all gas cocks and piping c) Adjust regulator d) Replace regulator
	7. Burner a) Defective burner	a) Replace burner

TROUBLESHOOTING INSTRUCTIONS

TROUBLESHOOTING GUIDE

Problem	Possible Cause	Corrective Action
IV. BLOWER RUNS; BURNER FIRES; FLAME SAFETY RELAY LOCKS OUT	1. Low Flame Current a) Dirt build-up on ceramic body of flame rod. b) Minimum fire set too low c) Defective burner	a) Clean dirt deposit from ceramic body and install protective boot b) Adjust minimum fire on modulating valve c) Replace burner
	2. Multi-Functional PC Board a) Low fire start set too low	a) Adjust modulating valve voltage between 10 and 13 Volts DC
	3. No Flame Current a) Ground connection open b) Wire termination oxidized	a1) Reference transformer to ground a2) Secure ground between control enclosure and burner a3) Tighten loose ground screws b) Clean terminal on flame rod and FSR and reinsert
	4. Fluctuating Flame Current a) Unit overfiring b) Minimum fire set too low c) Intermittent ground connection d) Loose terminal on Flame Rod e) Defective burner	a) Check manifold pressure b) Adjust minimum fire on modulating valve c) Tighten all ground points d) Remove jam nuts from Flame Rod. Reassemble with terminal located between jam nuts on Flame Rod. e) Replace burner
	5. Flame Safeguard Relay a) Defective FSR	a) Replace FSR
	6. High Limit a) High limit contact intermittent	a) Replace high limit
	V. BLOWER RUNS; UNIT HEATS; SHORT CYCLES WITHOUT RESETTING	1. Air Flow Switch a) Blower running backwards (SA350) b) Belts slipping (SA350) c) Blocked intake or discharge d) Air delivery below unit specs e) Clogged airflow tubing or pick-up ports f) Defective switch
2. Flame Safeguard Relay a) Defective FSR		a) Replace FSR
3. Operating Thermostat (CE-Smart™) a) Differential temperature setting too tight b) Open or short in thermistor circuit		a) Increase differential temperature setting b) Check wiring or replace thermistor
4. Damper Motor End Switch (optional) a) End switch making intermittent contact		a) Replace damper assembly

TROUBLESHOOTING INSTRUCTIONS

TROUBLESHOOTING GUIDE

Problem	Possible Cause	Corrective Action
VI. HIGH LIMIT TRIPPED	1. High Limit a) High limit will not reset	a) Replace high limit
	2. Unit Overfiring a) Manifold pressure too high	a) Adjust combination valve to obtain temperature rise specified on nameplate
	3. Inlet Damper (optional) a) Damper blades partially closed b) Defective damper motor	a) Adjust damper b) Replace damper assembly
	4. Low Airflow a) Blower running backwards (SA350) b) Belts slipping (SA350) c) Blocked intake or discharge	a) Reverse motor direction (SA350) b) Tighten and/or replace belts (SA350) c) Find and remove obstruction
	5. Temperature Control System a) Temperature control system does not modulate	a) See problem VIII
VII. BLOWER RUNS; UNIT HEATS; WILL NOT CYCLE OFF	1. Operating Thermostat a) Thermostat located improperly b) Thermostat differential setting too wide c) Defective thermostat	a1) Thermostat in cold draft-relocate a2) Thermostat not satisfied-turn down b) Reduce differential setting c) Replace thermostat
	2. Burner Service Switch a) Switch in LOCAL position	a) Place switch in REMOTE position
	3. Auxiliary Control a) Auxiliary contacts closed	a) Check auxiliary circuit wiring and contacts
	4. Misunderstood Control System Operation a) Control system doesn't function as expected	a) Review control system operational characteristics
VIII. MODULATING VALVE DOES NOT MODULATE; CONTINUOUS HIGH FIRE (Continued on next page)	1. Amplifier a) Wire not connected to amplifier terminal 3, 4, or 5 b) Defective amplifier	a) Reinstall wire b) Replace amplifier
	2. Discharge Temperature Sensor a) Discharge Air Temperature Sampling Tube clogged b) Open in sensor circuit c) Sensor cross-wired to amplifier d) Temperature Control System out of calibration	a) Clean Discharge Air Temperature Sampling Tube b) Replace the sensor if resistance measured at terminals 1 and 3 or 2 and 3 exceeds 6,000Ω c) Correct wiring terminations d) Perform appropriate calibration procedure (page 17)

TROUBLESHOOTING INSTRUCTIONS

TROUBLESHOOTING GUIDE

Problem	Possible Cause	Corrective Action
VIII. MODULATING VALVE DOES NOT MODULATE; CONTINUOUS HIGH FIRE (Continued)	3. Space Temperature Selector (CE-Smart™) a) Open in sensor circuit b) Induced voltage in field wiring c) Space sensor located improperly	a) Replace the sensor if the resistance measured is less than 3,500 Ω for the TS244A and 1,950 Ω for the TD244A b) Utilize shielded, twisted pair wiring c) Sensor in cold draft - relocate
	4. Modulating Valve a) Foreign material holding valve open	a) Replace valve
IX. MODULATING VALVE DOES NOT MODULATE; CONTINUOUS LOW FIRE	1. Class II Transformer a) No voltage output to amplifier	a1) Check for short in modulating valve coil a2) Replace transformer
	2. Modulating Valve a) Valve coil is open or shorted b) Plunger jammed c) Ruptured main or balancing diaphragm	a) Replace valve if coil resistance is less than 40 Ω or greater than 85 Ω b) Replace valve c) Replace valve
	3. Amplifier a) No output voltage to valve	a) With the wire removed from terminal 3 of amplifier, replace amplifier if the valve voltage does not exceed 18 Volts DC
	4. Space Temperature Selector (CE-Smart) a) Short in sensor circuit	a) Replace the sensor if the resistance measured is less than 3,500 Ω for the TS244A and 1,950 Ω for the TD244A
	5. Multi-Functional PC Board a) Terminal X has power b) Defective board	a) Determine power source b) Replace board

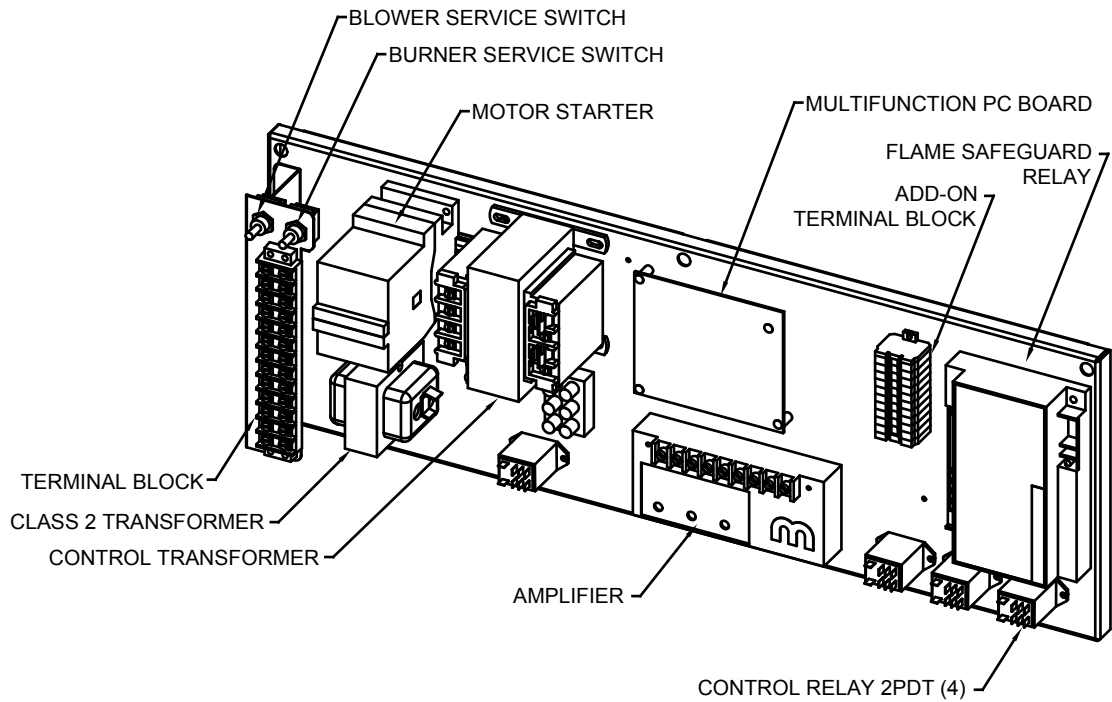
TROUBLESHOOTING INSTRUCTIONS

TROUBLESHOOTING GUIDE

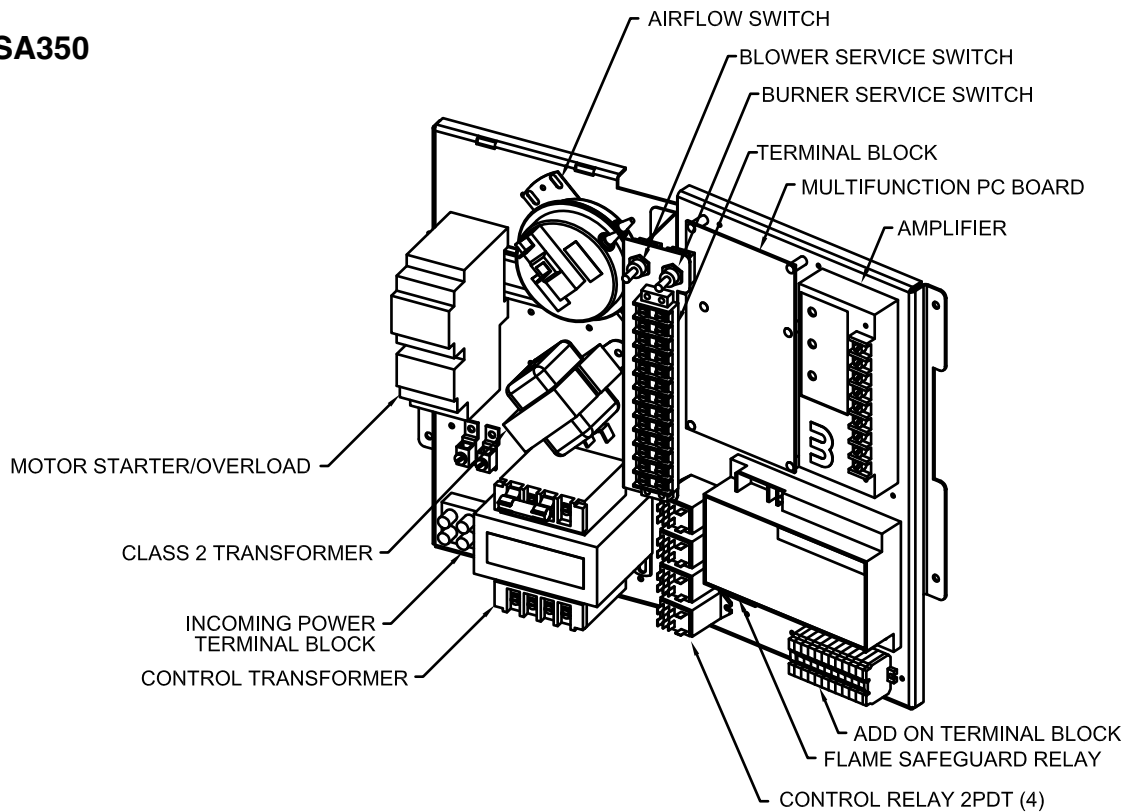
Problem	Possible Cause	Corrective Action
X. ERRATIC OR PULSATING FLAME	1. High Pressure Regulator a) Vent undersized b) Defective regulator	a) Enlarge vent piping size or reduce vent piping length b) Replace regulator
	2. Amplifier a) Hunting b) Temperature control system out of calibration c) Defective amplifier	a) Adjust sensitivity control dial counter-clockwise b) Perform appropriate calibration procedure (page 17) c) Replace amplifier
	3. Space Temperature Selector (CE-Smart™) a) Induced voltage in field wiring	a) Utilize shielded, twisted pair wiring

REFERENCE ELECTRICAL CONTROL ENCLOSURE

SA250

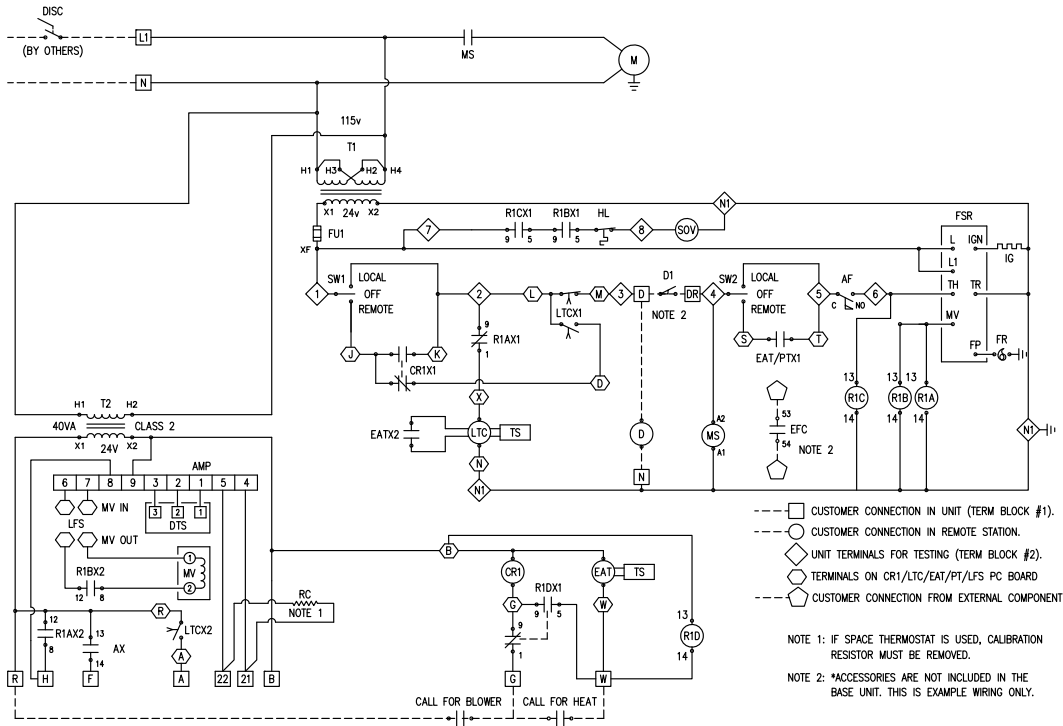


SA350



REFERENCE ELECTRICAL WIRING DIAGRAMS

SA250 Remote controls by others



MOTOR	VOLTAGE	UNIT AMPS
0.75 HP	115v 1ø	12.3A

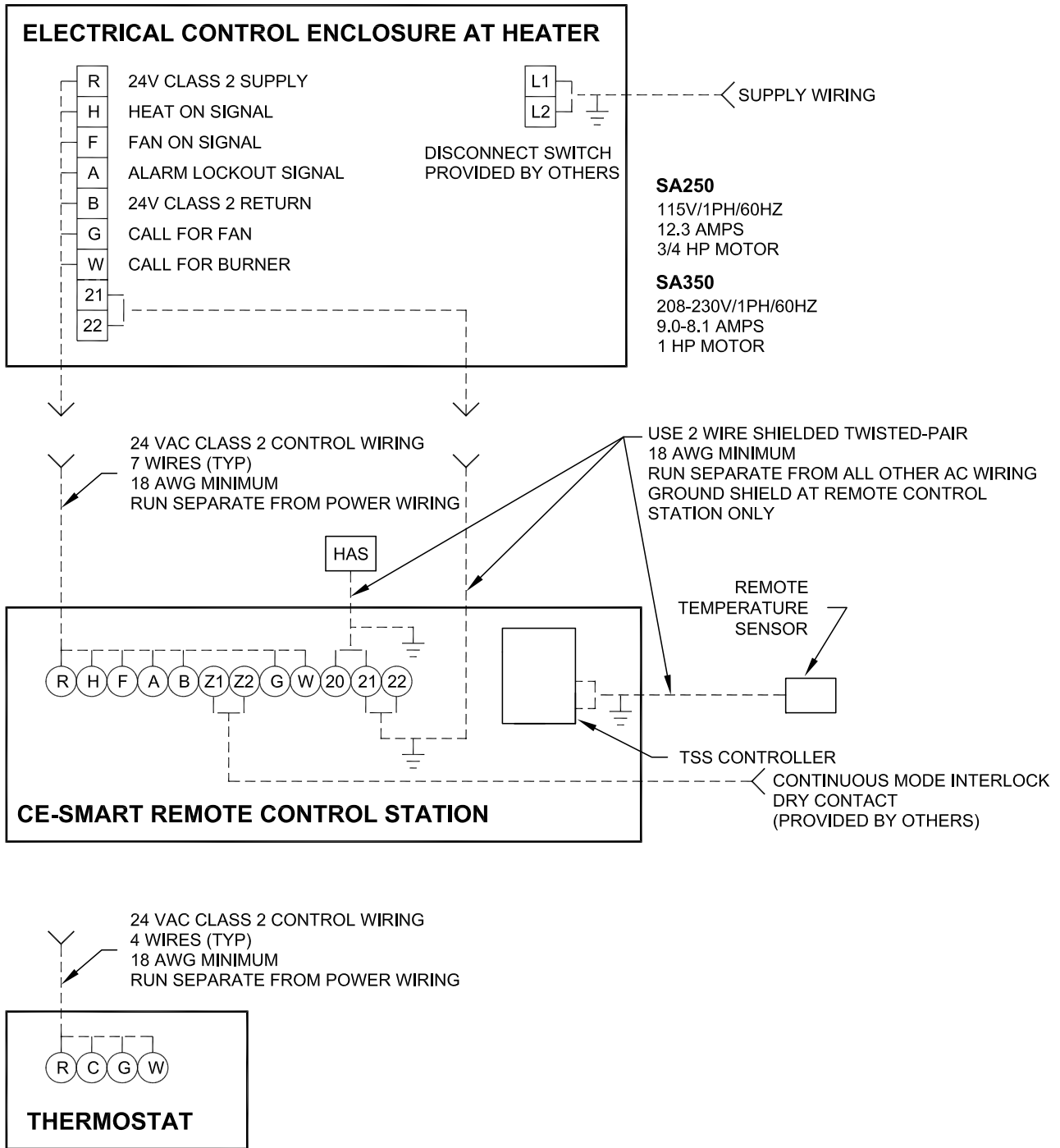
Symbol	Description
AF	Air Flow Switch
AMP	Amplifier Solid State
AX	Auxiliary Contact
CR1	Control Relay
D & D1	Damper Motor & End Switch
DTS	Discharge Temperature Sensor
EAT	Entering Air Thermostat
EFC	Exhaust Fan Contact
FR	Flame Rod
FSR	Flame Safeguard Relay (HSI)

Symbol	Description
FU1	Fuse 24 Volt Control
HL	High Limit
IG	Ignitor
LFS	Low Fire Start
LTC	Low Temperature Cutout
M	Motor
MS	Motor Starter
MV	Modulating Valve
PCB	Printed Circuit Board

Symbol	Description
PT	Purge Timer
R1A,B,C	Relays - Gas Valve
R1D	Relay - Thermostat Control
RC	Resistor - Calibration
SOV	Shut-Off Valve - Gas
SW1	Service Switch - Fan
SW2	Service Switch - Heat
T1	Multi-Tap Transformer (24 & 120 Volt)
T2	Class 2 Transformer (24 Volt)
TS	Temperature Sensor - LTC/EAT

REFERENCE

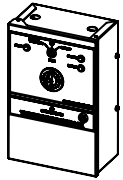
ELECTRICAL CONNECTION DIAGRAM



INDIVIDUAL COMPONENT DESCRIPTIONS

REMOTE CONTROL STATION

CE-SMART™ SYSTEM



The CE-Smart system includes a lockable NEMA 1 enclosure (9"W x 14"H x 5"D) equipped with a three position selector switch (Summer Ventilation - Off - Heating); a combination seven day programmable timer and thermostat (TSS); an override timer;

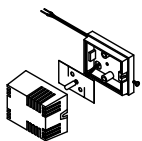
intermittent/continuous control; and indicating lights for blower operation (green), burner operation (red), and reset (amber).

The operator can control the heater from this panel provided the heater mounted disconnect is in the "ON" position and the service switches are in the "REMOTE" position. The TSS utilizes an encapsulated thermistor to sense space temperature. The adjustable differential is set by the selection of the ON and OFF temperatures. This control can accommodate separately programmed schedules for both the ventilation and heating modes. See the operating and programming instructions for the TSS Controller (page 20).

The intermittent/continuous control allows the heater to be operated in two modes. During unoccupied hours it operates intermittently based on a thermostat at maximum discharge temperature (see EDL - Space Heating Mode) for space heating. During occupied hours it operates continuously at modulating discharge temperature for make-up air (see EDSM - Continuous Make-Up Air Mode).

REMOTE CONTROL STATION COMPONENTS

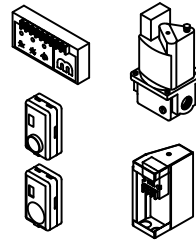
THERMISTOR (RTS)



The thermistor is wired to the temperature sensor terminal block. If remote location of the sensor is desired, the connecting cable must be wired between the thermistor and this point. The thermistor enclosure (SH-1) is packed in the remote control station for

shipment. It can be mounted on the exterior sides or bottom of the remote control station or a remote location within 500 feet using 18 gauge stranded, twisted-pair, shielded cable.

GAS CONTROL SYSTEM



The gas control system utilizes Maxitrol's Series 44 modulation controls. The discharge temperature sensor, which is mounted in the discharge duct, transmits a resistance signal back to the amplifier that corresponds to the discharge temperature. The amplifier creates a

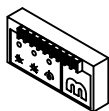
voltage output to drive the modulating valve to maintain the preselected temperature.

The system can be operated either intermittently as a space heater at maximum discharge temperature (EDL - Space Heating Mode) or continuously as a makeup air heater with the discharge temperature modulating to maintain the space temperature (EDSM - Continuous Make-Up Air Mode).

EDL - Space Heating Mode - The discharge temperature is controlled by the MAX setting on the amplifier (100-160°F). The heater cycles on and off based on the temperature settings of the space thermostat.

EDSM - Continuous Make-Up Air Mode (requires CE-Smart) - The discharge temperature modulates to maintain the space temperature selector. The adjustable temperature selector is typically mounted inside the remote control station and is set to the desired space temperature and it transmits a resistance output to the amplifier to control the discharge temperature. The non-adjustable space sensor is mounted in the space and transmits a resistance signal back to the amplifier that corresponds to the space temperature. The discharge temperature sensor is mounted in the discharge and transmits a resistance signal back to the amplifier that corresponds to the discharge temperature. The amplifier creates a voltage output to drive the modulating valve to maintain the selected space temperature by controlling the heater output between the MIN and MAX setting on the amplifier. The MIN dial setting determines the minimum discharge temperature the heater will deliver (40 to 80°F). The MAX dial setting determines the maximum discharge temperature the heater will deliver (100 to 160°F). When the space temperature drifts from the temperature selector setpoint by more than 3°F, the modulating valve is driven to the MIN or MAX discharge temperature, as applicable.

GAS CONTROL COMPONENTS AMPLIFIER (AMP)



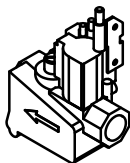
The amplifier creates a voltage output to drive the modulating valve to maintain the selected discharge temperature.

For EDL Mode, the discharge temperature is set at the amplifier.

For EDSM Mode, the range of the discharge temperature is set at the

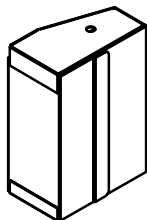
amplifier, however, the adjustable temperature selector controls when more or less heat is required.

COMBINATION VALVE



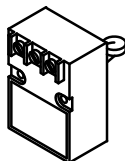
The combination valve serves as a manifold pressure regulator and redundant gas shut-off valve. The valve operates on 24 Volts AC power. The combination valve is rated for a maximum gas supply pressure of 14" WC.

DISCHARGE AIR TEMPERATURE SAMPLING BOX



The discharge air temperature sampling box is located on the side of the discharge, and is accessible from the electrical control enclosure side of the unit. The sampling box houses the high limit and the DTS. This box should not be tampered with unless performing the Calibration Procedures (page 17).

DISCHARGE TEMPERATURE SENSOR (DTS)



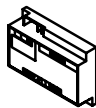
The DTS is mounted in the discharge of the heater. It senses the average discharge temperature and transmits a resistance signal back to the amplifier that corresponds to the discharge temperature.

FLAME ROD (FR)



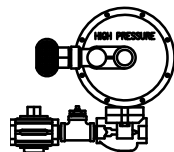
The flame rod senses the presence of flame and signals the flame safeguard relay. The presence of flame is detected by the flame rectification of the AC signal that is supplied to the flame rod thus creating the DC response. The resulting current flow produced can be measured with a DC microammeter. The reading should be steady and between 2.0 and 6.0 microamps (μA).

FLAME SAFEGUARD RELAY (FSR)



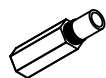
The flame safeguard relay supplies 24 Volts AC to the igniter for 4 seconds before the gas valve is energized. If the burner does not light (flame is not established within 7 seconds), this control will lock out gas flow until the control is reset. If flame signal is lost during burner operation, the control will allow one retry for ignition.

HIGH PRESSURE REGULATOR (HPR)



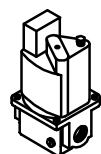
The HPR option is required when the gas supply pressure exceeds the nameplate rating for the heater. Unless otherwise specified, the HPR assembly is also furnished with a high gas pressure manual shut-off valve and a tap for measuring the upstream gas pressure. The HPR must be a positive lock-up type regulator which must be vented to outdoors. It is sized according to the gas supply pressure and the capacity requirements of the heater.

IGNITER (IGN)



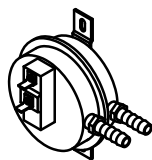
The hot surface igniter is the ignition source for lighting the gas in the burner. It is made of silicon carbide which is very fragile. Care should be used in handling. It operates on 24 Volts and the current ranges from 1.3 to 1.7 amps. It will reach temperatures in excess of 2400°F during the ignition trial.

MODULATING VALVE (MV)



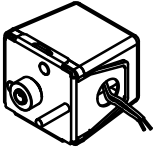
The MV responds to a 4 to 24 Volt DC signal from the amplifier to modulate the flow of gas to the burner. The low fire adjusting screw is located on the side of the valve under the dust cover.

HEATER COMPONENTS AIRFLOW SWITCH (AF)



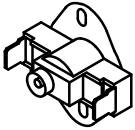
The airflow switch senses the pressure drop across the burner. It is factory set and not adjustable. It is designed to prevent burner operation if the airflow drops significantly below the minimum design airflow of the heater.

DAMPER MOTOR



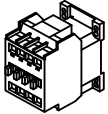
The damper motor operates on 24 Volts AC and switches power to the motor starter when the damper blades are fully open by the closure of the damper end switch. The damper end switch is an auxiliary switch which has been factory set to operate when the damper is fully open. The damper will spring closed when the heater cycles off.

HIGH TEMPERATURE LIMIT (HL)

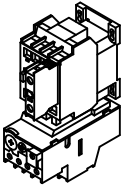


The high limit opens when discharge temperature exceeds 180°F. This limit must be manually reset.

MOTOR STARTER (MS, OL, AUX)

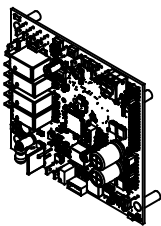


For SA250 heaters, the motor starter is a motor rated contactor that switches power to the blower motor.



For SA350 heaters, the motor starter assembly consists of a motor rated contactor, overload relay and auxiliary contact. The overload relay protects motor from excessive current or single phasing. If overload relay trips, it must be reset manually. The auxiliary contacts are used in gas valve safety circuit as an indication blower is operating, and as an optional exhaust fan contact for interlocking other equipment with operation of the heater.

MULTI-FUNCTIONAL PC BOARD



The multi-functional PC board provides five (5) separate functions as follows:

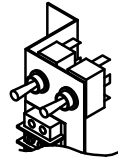
- 1) **Blower Relay (CR1)** which is energized on “call for blower” from the remote control station.
- 2) The **LTC (Low Temperature Cutout)** circuit functions to shut down blower in approximately 3¹/₂ minutes if either of the following occurs: (a) Inlet temperature drops below LTC setpoint (40, 45, 50, or 55°F) in ventilation mode; or (b) the gas valve fails to remain energized during a heating cycle.
- 3) The **EAT (Entering Air Thermostat)** circuit functions automatically to turn off the burner when the outdoor temperature reaches the EAT setpoint (45, 50, 55, 57.5, 60, 62, 64, 66, 68 or 70°F).

4) The **PT (Purge Timer)** circuit function is preset at the factory to provide four air changes within the heater cabinet prior to an ignition attempt (normally set at 4 seconds). If inlet ducting is attached to the heater, the delay time can be increased to 8, 16, or 32 seconds, as applicable.

5) The patented **LFS (Low Fire Start)** circuit function is provided to limit the initial heater firing for the first 15 seconds of a heating cycle. The voltage to the modulating valve is adjusted between 9 and 13 Volts DC by an adjustable potentiometer on the PC board. The multi-functional PC board has a single digit LED display to identify current mode of unit operation as follows:

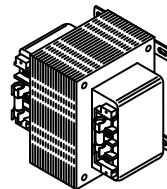
- 1: Ventilation mode
- 2: Heating mode, pre-purge
- 3: Low fire start
- 4: Normal heating mode
- 8: Unit in reset

SERVICE SWITCH (SS)



The service switches are mounted in the electrical control enclosure. In the “LOCAL” or “OFF” position, the service technician has local control of the heater. These switches must be placed in the “REMOTE” position for normal control from the remote control station.

TRANSFORMER (T1)

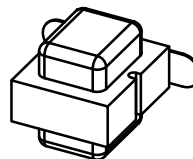


SA250 heaters are furnished with a 24 Volt secondary transformer.

SA350 heaters are furnished with a dual 115/24 Volt secondary transformer.

A FLM-6.25 secondary fuse is provided in the Class I transformer circuit to protect downstream components from short circuit. Do not increase the fuse rating over that which is specified.

TRANSFORMER (T2)



The Class II transformer provides 24 Volt supply for gas modulation and remote control circuits. The transformer output current is inherently limited to protect downstream components from short circuit.

ANSI/ASHRAE/IESNA STANDARD 90.1

Overview

Energy efficient, Genuine Cambridge® direct gas-fired heating equipment can comply with the requirements of ANSI/ASHRAE/IESNA Standard 90.1-2010. Compliance is shown on the Cambridge heater nameplate.

Purpose of ASHRAE Standard 90.1

ASHRAE Standard 90.1 provides minimum requirements for the energy efficient design and construction of new commercial buildings in the United States. The standard covers the entire building, setting minimum equipment efficiency levels for components that may be used, rather than setting standards for component manufacturing. The provisions of this standard do not apply to single family houses, low rise residential buildings and buildings (or portions of buildings) that use energy primarily for industrial, manufacturing or commercial processes.

Compliance Requirements:

The following are required for Cambridge heaters to comply with Standard 90.1:

- **Controls (Section 6.4.3)**

Total airflow of all heaters less than 10,000 cfm
- The Cambridge CE-Smart™ System will meet the standard. A properly configured building DDC system with the necessary programming for zone control, automatic shutdown and setback can also meet the standard.

Units intended to operate continuously - No special controls are required to meet the standard.

- **Damper (Section 6.4.3.4.3)**

A damper is required on each heater. The Cambridge Motorized Inlet Damper (MID) will meet the standard.

- **Labeling (Section 6.4.1.5.1)**

The heater must be labeled to indicate that it complies with the requirements of the standard. The nameplate of Cambridge heaters includes the required labeling.

- **Efficiency (Section 6.4.1.3)**

Direct gas-fired heating equipment has no minimum efficiency requirement. However Cambridge certifies that its equipment has a 100% combustion efficiency (Ec) and a 92% thermal efficiency (Et).

Cambridge Air Solutions reserves the right to change specifications, modify the design and/or substitute equivalent materials without notice as the result of code requirements, product enhancements, ongoing research/development and vendor changes beyond our control.



760 Long Road Crossing Dr., Chesterfield, MO 63005
Phone: (636) 532-2233 (800) 899-1989, Fax: (636) 530-6133
www.cambridgeair.com