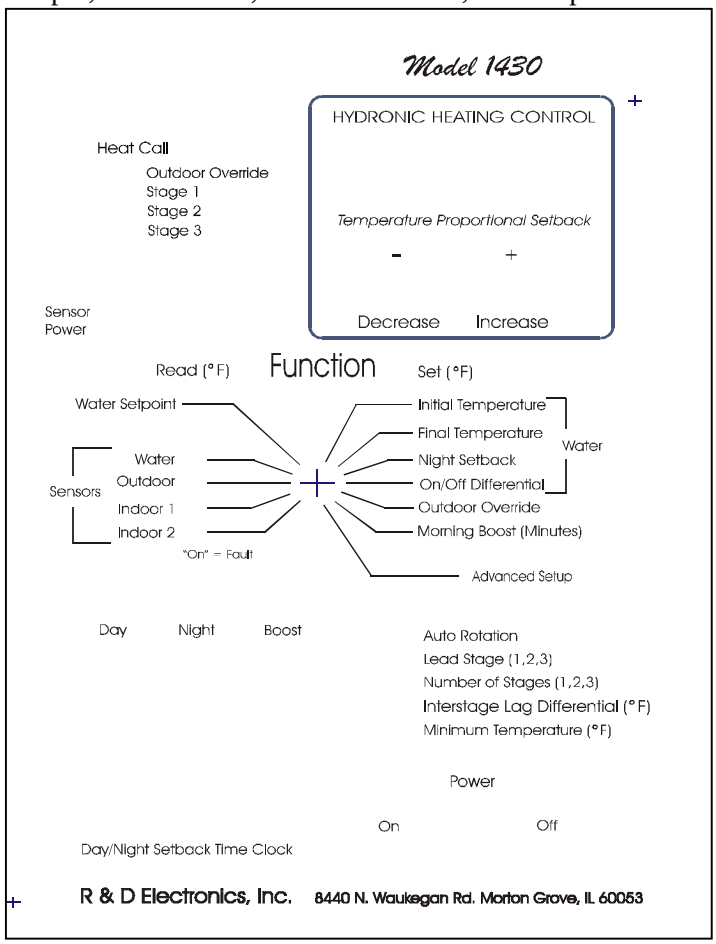
OWNERS MANUAL -- Model RD1431, 1432, 1433
1, 2, and 3 Stage Hot Water Heating Control

The R&D Electronics Model RD1430 series controls consist of a main panel, a boiler water temperature sensor, an outdoor sensor, and up to 2 optional indoor sensors. The main panel has 16 LED's which indicate all important ON/OFF operating conditions, including heat call, pump and air damper, sensor faults, outdoor override, and the present time schedule. A simple rotary switch labeled READ °F, and SET °F operates the 3 digit LCD display.



Control Operation: The boiler water temperature is determined by (a) outdoor temperature, (b) operator initial water setpoint, (c) operator final water setpoint, (d) the amount of night setback, and (e) day/night time clock schedule. The computed water setpoint varies linearly from the operator Initial Temperature setting at +70 °F to the Final Temperature at -10 °F

If the boiler water temperature falls below the calculated setpoint by ½ the amount of the on/off differential, relay circuits operating boiler stage-1 will close. If the boiler water temperature falls an additional amount equal to the inter-stage lag differential, relay circuits operating stage-2, then stage-3 (models RD1432 and RD1433) will close.

When the outdoor temperature exceeds the Outdoor Override setting (typically 55 °F) the boiler and the main circulating pump will shut down. Four sensor LED's indicators warn the operator of readings that are out of range, and damaged sensors or sensor wiring.

At 70 °F outdoors, the water temperature setback starts out at its initial value displayed in the SET menu. As the outdoor temperature decreases, the water temperature setback decreases towards its final value of zero at -10 °F outdoors. The water temperature setpoint at -10 °F outdoors will equal the final temperature and there is no setback. At 30 °F outdoors, the water temperature setback will be at ½ of its initial amount. During the short morning boost period, the water temperature will be increased by the same amount of the setback. For an eight-hour setback period, initial setbacks as great as 60 °F pose no threat of tenant discomfort or frozen pipes

At the beginning of the DAY set period (when the setback timer first changes to ON), the morning BOOST period begins. During the boost period, the water temperature will be increased the amount of the night setback.

Model Number Information: RD1430 printed on the panel is the generic number for the product series. Turn power OFF, then ON**.** The LCD digit to the left of the decimal point represents last digit of the model number (or the number of boilers or boiler stages that will be supported). The digit to the right of the decimal point refers to the software version. *Panels may be returned to the factory to increase the number of supported boiler stages for an additional charge.*

DESIGN HIGHLIGHTS

* Motorola MC68HC11 operates in single chip mode. Internal ram, rom, and eeprom.
* Operator setpoints are retained in eeprom (permanent memory).
* Patented night setback proportioned to outdoor temperature.
* Calculates the Morning Boost temperature according to the amount of night setback.
* Includes (1) one outdoor, (1) strap-on water sensor. Optional: (2) room zone sensors.
* Warm Weather Shutdown or outdoor override
* Controls the main circulating pump and optional combustion air damper
* Monitors actual building temperatures in up to two room zones.
* Manual or Auto Boiler Rotation daily or weekly
* All sensor have fault protection circuits and LED indicators.
* Setback Timer weekday/weekend programmable with 4 months battery reserve.
* Minimum boiler water temperature to prevent condensation.
* Manual bypass on all relay outputs.
* 2 second interstage activation delay
* Plug-in panel for quick service without disturbing the field wiring or manual bypass.
* 16 Gauge steel enclosure with means for a padlock

Function Switch: Rotate the Function switch to READ °F to monitor the water temperature setpoint, current water temperature, outdoor temperature, and the two optional indoor room temperatures. Rotate Function switch to SET °F to read and adjust the six operator setpoints. *The function switch may be left at any position without affecting control operation.*

OPERATOR SETUP MENU

1 INITIAL TEMPERATURE {90}

For most hot water baseboard radiant heating systems, the INITIAL temperature will be set between 80 and 100 °F. An increase in INITIAL temperature will not, contrary to most other systems, increase the computed water temperature setpoint at the final temperature (-10 °F outdoors). In this product, the initial temperature is not a parallel shift, the slope of the reset curve changes with the initial or final temperature settings. If it is cold indoors during warm weather, increase the INITIAL temperature 2 °F for every 1 °F you would like to increase the indoor room temperature. Wait 24 hours after readjustments to allow the indoor temperature to stabilize at the new setpoint. *Note: Lower settings will be necessary with cast iron or floor radiant systems.*

2 FINAL TEMPERATURE {200}

Increasing the final temperature will increase the computed water temperature setpoint most during cold and least during warm weather. A final temperature increase of 3 °F will increase room temperatures approximately 1 °F. The calculated setpoint may become as high as 240 °F as outdoor temperature falls below -10 °F. The boiler has a hi limit safety control connected in series with the RD1430 which prevents water temperatures from exceeding a safe temperature.

Most hot water systems have finned baseboards, requiring final temperature settings as high as 200 °F. Other hot water system using larger radiators will require a final water temperature of only 170 °F. Systems with fan coils, large cast iron radiators, or floor radiant heat may require a final temperature of only 140 °F. The optimum initial and final settings can best be determined by installing zone monitoring sensors and performing trials.

3 NIGHT WATER TEMPERATURE SETBACK {40}

The displayed value represents the setback only at 70 °F outdoors, and can be thought of as the ***initial water temperature setback***. The computed water temperature setback decreases as outdoor temperature decreases. At 30 °F outdoors, the water temperature setback is 1/2 the initial value. At -10 °F outdoors, the water temperature setback is zero.

Increasing the ***initial setback*** will improve fuel savings. Hot water systems take a long time to cool down, and boiler cycling can be reduced enormously during setback. Because setback is proportioned to outdoor temperature and recovery problems are eliminated, very large initial water temperature setbacks are practical. Over a nominal setback period of 8 hours, with outdoor temperature in the range of 20 to 40 °F, and with an initial setback of 60 °F, indoor temperatures may decline only 3 to 5 °F during the setback period.

4 ON/OFF DIFFERENTIAL {12}

A setting of 15 °F is correct for most hydronic systems. On a typical 30 °F winter day, if the heating cycle length is not in the 4 to 8 minute range, then set the differential higher or lower as needed.

Copper tube boilers will require higher settings, while cast iron boilers will require lower. Too low a differential setting will cause short cycling and fuel waste, and too high a setting may cause room temperatures to rise and fall excessively. If the heating cycle length is too short with a differential setting of 30 (most common with copper tube boilers), then the circulating sensor will have to be moved to the return water side of the boiler.

5 OUTDOOR OVERRIDE (Warm Weather Shutdown) {56}
Set between 55 and 65 °F

6 MORNING BOOST MINUTES {1:00}
The boost period begins at moment the time clock switches from night to day. Use a 60-minute boost for an 8 hour setback or a 30 minute boost for a 4 hr. setback period.

ADVANCED SETUP MENU

1 AUTO BOILER ROTATION {NO}
YES will allow the LEAD STAGE to advance each morning at the beginning of the boost period.

2 SELECT LEAD STAGE {1}
You may manually select the lead stage, or if auto rotation is ON, this number will automatically advance. The model number determines the maximum lead stage setting.

A qualified heating contractor should set the following 3 items:

3 NO. OF BOILER STAGES {1 to 3}

4 INTER-STAGE LAG DIFFERENTIAL {1 to 4}
If the water temperature drops below the computed setpoint, minus ½ the heating cycle differential, minus the lag differential, the next boiler or stage will turn ON. This process continues until all the boilers or boiler stages are ON. There is no lag differential setting on a model RD1431 which operates only one stage.

5 WATER ABSOLUTE MINIMUM TEMPERATURE {50}
Flue gases may condense and cause a boiler to sweat under certain conditions. The condensate may appear on fire tubes, cast iron sections, or the burner itself, etc. Consult the boiler manufacturer to determine if a particular model boiler requires a minimum temperature setting to protect it from corrosion. A minimum temperature setting of 130°F will reduce boiler condensation, but may cause the building to overheat in warm weather. It may be necessary to install a piping system which includes a mixing valve to blend supply and return water.

Manual Bypass: Turn POWER switch OFF. Open the front panel door and set toggle switches according to labels. Sw-1 operates the main circulating pump, Sw-2 operates boiler stage-1, Sw-3 operates boiler stage-2, Sw-4 operates boiler stage-3, (Optional) Sw-5 operates boiler room combustion air damper. *Front panel may be removed for service and bypass switches will continue to function.*

Setback Timer: -- When the Day/Night Timer display indicates "On", control is in the DAY period, whereas "Off" is Night. The Day and Alternate Timers allow 6 "On" and 6 "Off" entries. A 5-day (MO thru FR) and a 2-day (SA SU) group schedule will program the entire week using only 2 of 6 available schedule periods. Battery backup will keep the setback timers running for 4 months without power. *Replace clock battery every 3 years to achieve maximum memory backup interval. To prevent damage to the main circuit board, use only Ni-Cad or NiMH batteries.*

-- Day/Night Timer Programming Procedure --

1. Setting time of day: --
Press and hold (L) key, while at the same time press the Day key to advance the day of the week.
Press and hold (L) key, while at the same time press the h+ key (hour increase) for the correct hour.
Press and hold (L) key, while at the same time press the m+ key (minute increase) for the correct minute.

2. Program Monday thru Friday night setback: -- Press Timer key and the words "TIMER 1 ON" will appear. ON is the start of the Day period, and OFF is the start of Night or setback. Press the Day key 8 times and MO TU WE TH FR will appear. Press h+ and m+ keys to program Monday thru Friday startup (day). Press Timer key and "TIMER 1 OFF" will appear in the display. Press Day key 8 times and MO TU WE TH FR will appear. Press h+ and m+ keys to program Monday thru Friday setback (night). The most common schedule is ON 5:30AM and OFF 10:30PM.

3. Program Saturday and Sunday night setback: -- Press Timer key and the words "TIMER 2 ON" will appear in the display. Press Day key 9 times and SA SU will appear. Proceed as before to enter ON (day), then OFF (night) schedule. Press (L) key to return to time of day. The most common schedule is ON 6:00AM and OFF 11:00PM.

4. To Delete a program entry: -- Select with Timer key. Press h+ and m+ until "-- --" is displayed. To clear all memory, press the tiny key labeled "reset".

5. Other programs: -- 1. Use 6 schedules, 5 separate schedules for the five week days, and use the 6th schedule for SA SU. 2. Use 3 schedules, the 1st schedule for the five week days, and the 2nd and 3rd schedules for SA and SU.

6. Day or Night Schedule Override: -- Pressing the long narrow key switch at lower right corner of clock changes the display from reading "On" (Day Period) to "Off" (Night Period) or the reverse. The timer will automatically process the next scheduled setpoint change, but remains in the manually selected set period until such time.

INSTALLATION PROCEDURE

MOUNTING AND WIRING THE CONTROL CHASSIS

1. Mount the control chassis on a wood buffer, not directly to a brick basement wall. You may find it convenient to remove the front panel from the chassis while mounting. The chassis should NOT be mounted on an outside basement wall, as efflorescence and water damage is more likely. Avoid mounting the heating directly to the boiler or burner.

2. Mount a dedicated 24V AC 20VA power transformer, along with its 120 VAC power disconnect switch where convenient. Be certain that the 120V AC supplying the transformer is not switched on or off by pressure controls, or other safety limit devices. DO NOT CONNECT ANY OTHER LOADS TO THIS TRANSFORMER.

3. Complete all sensor, power and boiler switching wiring according to the wiring diagram on page 12.

4. Reinstall the front panel. BE CERTAIN THAT 24V AC POWER IS OFF, AND THAT THE PROPER POLARITY FOR THE 20 PIN CABLE CONNECTOR IS MAINTAINED. Do not force the cable connector into the socket; it may be installed in only one direction.

INSTALLING WATER TEMPERATURE SENSOR

Two types of sensors are available, well or strap on mounting. The well type will fit into a standard Honeywell (T.M.) model 123869 or 123870 sensor well. It is essential that enough conductive heat paste be inserted into the well before inserting the sensor. The screw or clip on the end of the sensor housing will secure the sensor to the well. Connect with two conductor-shielded wire.

The strap-on sensor requires 2 hose clamps or equivalent included with the control to fasten the sensor to the supply or return pipe. When two or more boilers are piped together, the supply water sensor should be placed just after the last "T" connection. For low water volume or copper tube boilers, the strap-on sensor may need to be mounted on the return side of the boiler to prevent short cycling. Connect the water temperature sensor with 2-conductor shielded wire. The pipe should first be clean to assure that the sensor will read properly, and the sensor element in the center of the aluminum bar should be covered with conductive heat paste.

LOCATING AND MOUNTING THE OUTDOOR SENSOR

The outdoor sensor housing attaches to a 1/2" electrical conduit pipe mounted vertical, and preferably on the north outside wall of the building. Place the sensor in an open area, not underneath a porch. Keep it away from where water can accumulate on it, or exhausted air from the building could cause false readings. The conduit pipe should have parallel offset bend near the top so that the sensor head is more than 2" away from the building wall. If an east or west outside wall must be used, be sure that the building itself, or the building next door provides shade. **Do not mount the outdoor sensor on a south wall in direct sunlight. It is nearly impossible to effectively shade it with any type of shield.**

1. You may use #18-3 or #18-4 thermostat wire for the outdoor sensor, but #22 or larger 2 cond. shielded wire is stronger and is less likely to crack or tear. The shield (or third wire) will help protect the sensor from static damage when attached to electrical ground.

2. Drill a 3/8" hole in the brick where the outdoor sensor is to be mounted. Chip or drill a 1" dia. hole about 1/2" deep around the 3/8" hole so that one end of a 1/2 in. "L" can go part way into the brick to protect the wire from damaged.

3. Drill mounting holes in the outside brick wall for two #10 plastic anchors

4. Form the parallel offset bend at the top 2-foot section of a 5 to 10 foot length of 1/2" electrical conduit.

5. Feed the wire through the 1/2" "L", the conduit, and the sensor head, and fasten the sensor head to the conduit. Connect the cable to the sensor PC board (+), (-), and (Electrical Gnd.) per wiring diagram.

6. Fasten the electrical conduit to the wall using #10 sheet metal screws and plastic anchors or similar.

MOUNTING AND WIRING OPTIONAL ROOM SENSORS

You may use #18 or #20 gauge thermostat wire for runs of up to 500 feet. There are a few rules to observe.

1. Use 4 or 6 conductor wire and route two or three sensors within close proximity (such as apartments above and below). It is a good practice to install junction boxes at basement locations and split off vertical runs from there. This technique allows convenient test points in order to locate shorts or opens, should they occur. Another plan is to bring #18-4 wire into a first floor sensor box, connect a second #18-4 wire to the remaining 2 wires from the heating control, and run the second #18- 4 up to the top floor.

2. Do not support sensor wires from hot water, or steam piping. Do not wrap wires around objects, use cable ties to shore up the wires after you have finished loosely stringing them. Where ever possible, affix cables to 1/2" electrical conduits, they make excellent wiring attachments for cable ties.

3. Do not use staples to support wires anywhere except within apartments. It is difficult to find staple shorts, and they may not show up until months after the installation is complete. Standard coaxial cable fasteners and nylon cable ties work well in basements.

4. Pull the indoor sensor wire through the large center egress hole in the plastic sensor base first. Mount the sensor base using the hole closest to the wire egress first. If you do not hit the wood lath in the plaster, or the hole becomes stripped, rotate the base 180 degrees. An offset in the mounting holes relative to wire egress hole allows a second chance to hit lath.

FIELD SERVICING

Main Panel and terminal board testing:
If the 3AG 1A fuse on the terminal board is bad, you may try replacing it. On rare occasions, there may be a fault on the terminal board. It is easiest to replace the main panel with a known good panel before attempting to determine whether the terminal board is defective. You may order field replacements for either board. *When panel exchanges are necessary, manual bypass switches will operate the boiler even after removal of the panel.*

If the Green Sensor Power LED is OFF or is dimly lit, proceed with steps 1 thru 6 below to determine whether sensor shorts are the cause of the problem, or whether the panel power supply has failed.

Water and Outdoor Sensor testing:
1. Place 3 1/2 digit volt meter or DVM (-) at **TS1** terminal 2 [outdoor sensor (-)], and DVM (+) at **TS1** terminal 3 [water temperature sensor (+). Verify that DVM reads 13 to 14 Vdc, or replace front panel.

2. Move DVM (+) to **TS1** terminal 1 [outdoor sensor (+)] and measure the outdoor sensor voltage, then look up the corresponding temperature on the chart in Table I. Replace the sensor if the DVM reading does not correspond with the outdoor temperature. Replace panel if outdoor temperature reading at the control is not within +/- 2 °F of the value in the look-up table.

TABLE I -- WATER & OUTDOOR SENSOR - TEMPERATURE TO VOLTAGE CONVERSION CHART

-20 F = 2.44 V	70 F = 2.95 V	160 F = 3.44 V
-10 F = 2.50 V	80 F = 3.00 V	170 F = 3.50 V
0 F = 2.55 V	90 F = 3.05 V	180 F = 3.55 V
10 F = 2.61 V	100 F = 3.11 V	190 F = 3.61 V
20 F = 2.66 V	110 F = 3.17 V	200 F = 3.66 V
30 F = 2.72 V	120 F = 3.22 V	210 F = 3.72 V
40 F = 2.77 V	130 F = 3.27 V	220 F = 3.78 V
50 F = 2.83 V	140 F = 3.33 V	
60 F = 2.89 V	150 F = 3.39 V	

Room sensor testing: If a sensor warning light is on, you will need to know if the sensor wiring is open, shorted, or whether the sensor is actually defective. The sensors are extremely reliable, and wiring defects are 50 times as likely as defective sensors. If radiators are turned off within an apartment, it becomes unusually cold and the sensor warning light may turn on and falsely indicate a bad sensor. If room temperatures exceed 97 °F., this will also turn on a sensor warning light even though the sensor is good. *If no sensors are functioning, the boilers will remain off.*

Problem: All the sensor-warning lights are ON. You must determine whether the panel is good.

1. Connect a digital voltmeter DVM **(-)** lead to **TS1** terminal 2 [outdoor sensor (-)] or sensor common. Connect the DVM **(+)** lead to the **(+)** terminal of any room sensor input. Verify DVM reads 13.0 to 14.0 Vdc. If not true, then the main panel is defective or there are two shorts in the control field wiring. See step 3 below.

2. *Testing for reversed sensor polarity and shorted lines:* If in step 1 the DVM reads 12.0 to 14.0 Vdc, then (1) sensor wiring is shorted, or (2) the sensor polarity is reversed. Try disconnecting the sensor and reversing the wiring polarity.

3. Sometimes a **(+)** sensor wire will short to ground elsewhere in the building. If there is an additional system short to conduit ground elsewhere in the field wiring, it will be necessary to trace both shorts before reconnecting the defective sensor line. Two shorts in your system can result in "grounding" of the +13.5 Vdc. If there is dual "grounding", or if the panel is bad, the *Green Sensor Power LED* will be off or barely visible. Isolate each sensor from the terminal board one at a time to locate the first short. The second short is usually in the 24 Vac transformer powering the control. *A transformer secondary short to the core cannot always be found with an ordinary DVM.* You may have to try replacing the 24 Vac transformer to resolve the problem.

4. *Test the microprocessor analog inputs:* Connect the DVM **(-)** lead to the outdoor sensor **(-)** terminal or common. Connect the DVM **(+)** lead to the zone sensor **(-)** terminal under test. The voltage at the **(-)** terminal should be directly proportional to **Table 2**, the room sensor temperature chart. The sensors should read between 2.1 and 3.1 volts (60 to 85 °F). The LCD display on the front panel should read the correct temperature.

5. *Testing for an open line:* If in step 1 the DVM reads 0, then the line is either open, or the sensor is defective. Try disconnecting the sensor from the control. Use your DVM in the Ohms position to read the resistance of the line and with the sensor still connected. For most DVM's, the resistance of a sensor will be between 1 and 10 Meg. Ohms (if you're lucky enough to be able to read it). If you can read the resistance correctly, then the wire is probably OK, and the sensor itself is defective. Otherwise, you may have to go to the apartment and measure the voltage across the sensor. If you measure +13.5 Vdc without the sensor connected, then the line is good. If the sensor is good, you will read approx. 2.5Vdc across the sensor, depending upon room temperature.

6. If the results of the above steps indicate a shorted line, then you will either have to replace the entire line, or cut the line in half, then half again, etc. to determine where the short is located. Most often, it will be due to a staple through a wire within an apartment, or the wire may have been cut off at floor level due to remodeling.

TABLE II -- ROOM SENSOR VOLTAGE TO TEMPERATURE CONVERSION

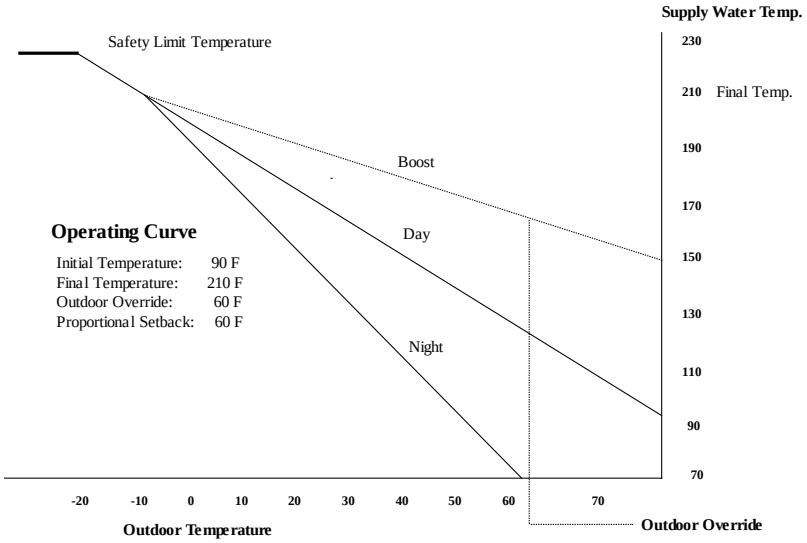
SENSOR		SENSOR		SENSOR	
Vdc	°F	Vdc	°F	Vdc	°F

2.10	60	2.46	69	2.82	78
2.14	61	2.50	70	2.86	79
2.18	62	2.54	71	2.90	80
2.22	63	2.58	72	2.94	81
2.26	64	2.62	73	2.98	82
2.30	65	2.66	74	3.02	83
2.34	66	2.70	75	3.06	84
2.38	67	2.74	76	3.10	85
2.42	68	2.78	77	3:14	86

ORDERING INFORMATION

Note: Standard product includes 800E outdoor sensor and 600S strap-on water temperature sensor. Please specify 600W immersion (well) sensor when required.

Model No.	Product Description
RD1431	single stage (one on/off boiler)
RD1432	two stage (two separate on/off boilers, or one lo/hi/lo boiler)
RD1433	three stage (three separate on/off boilers)
600S	Strap-on water temperature sensor
600W	Well (immersion) water temperature sensor
800E	Outdoor sensor



Operating Curve

Electrical specifications:

Input power: 24 VAC 20 VA.

Output switching :

24 VAC 4 amps SPST.

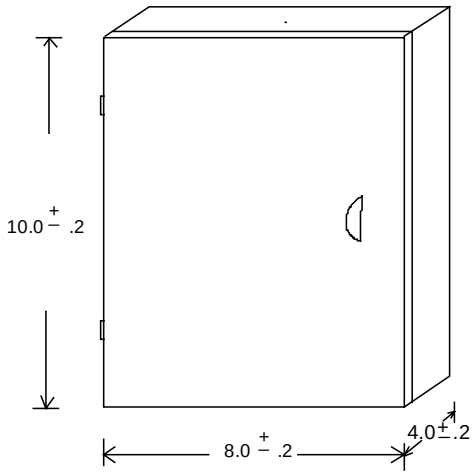
Accuracy: +/- 1.0 °F display, +/- 4.0 °F water sensor, +/- 1.5 °F outdoor sensor
+/- 1.5 °F optional room sensors

Operating or control range: 60 to 240 °F

Water temperature setback:	Approaches zero as Outdoor °F decreases from +70 °F to – 10 °F
Morning boost:	0 to 4:00 hrs.
ON/Off differential:	1 to 30 °F
Auto rotation:	yes (RD1432 and RD1433)
Rotation sequence:	daily or weekly, stages change 1,2,3 : 2,3,1 : 3,1,2
Boiler and pump override:	0 to 120 °F outdoors
Sensor source resistance:	10K ohm water, 1 ohm outdoor, 500 ohm indoor
Sensor field wiring:	water, #22, 2-cond. Shielded, outdoor #18-3indoor #18-2 or
Setback timer:	5-day 2-day, or Mo,Tu,We,Th,Fr separately and weekend days together 4 mo. Battery reserve NiMHi or NiCad Battery

MECHANICAL SPECIFICATIONS

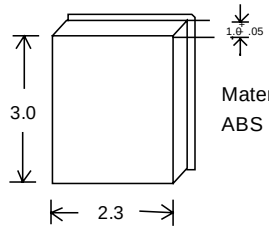
Material : .065 steel



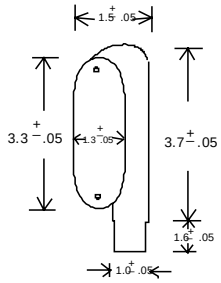
CHASSIS ENCLOSURE

Note : 1 Dimension in inches.

ROOM SENSOR HOUSING

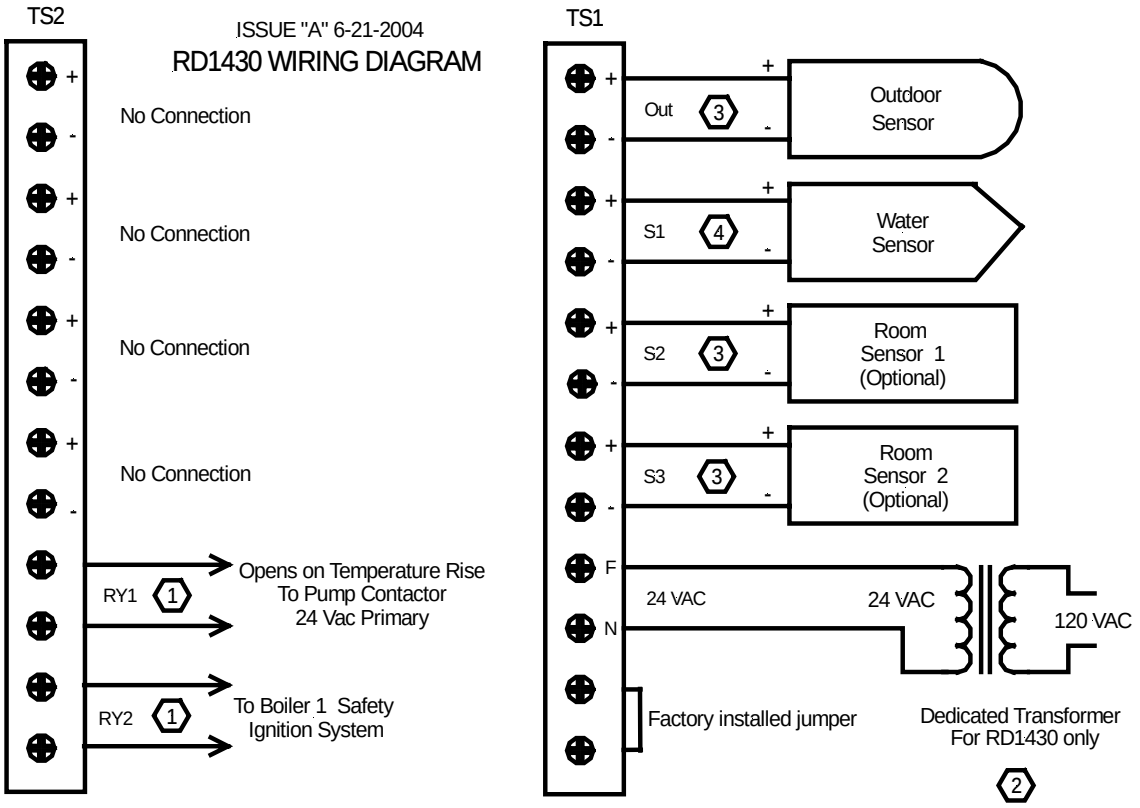


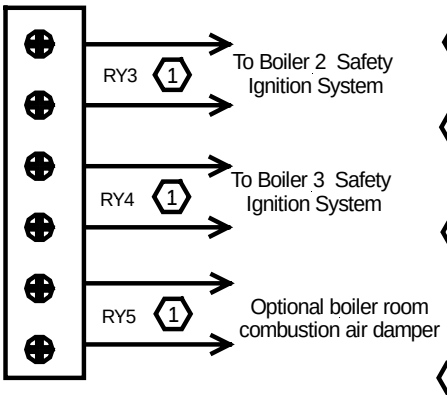
Material :
ABS Plastic



Material :
Aluminum

OUTSIDE SENSOR HOUSING





1. **Dry Contacts, rated 24 Vac. No power is supplied by the RD1400 to operate burner control circuits.**

2. **Do not power any other devices from the transformer that powers the RD1430.**

3. Use #18-3 thermostat wire or #22 3-cond shielded wire for outdoor sensors. Room sensor wiring can be #18-2 thermostat wire, shielding not required.

4. **Use #22 2-cond. shielded wire for the water sensor. Connect the shield to the (+) terminal at the control. Leave shield un-terminated inside the sensor enclosure.**

Note : RD1430 chassisis may be electrically grounded, but DO NOT GROUND field wiring terminals or the water sensor shield (see number 4 above). Ground only the outdoor sensor Gnd. terminal.