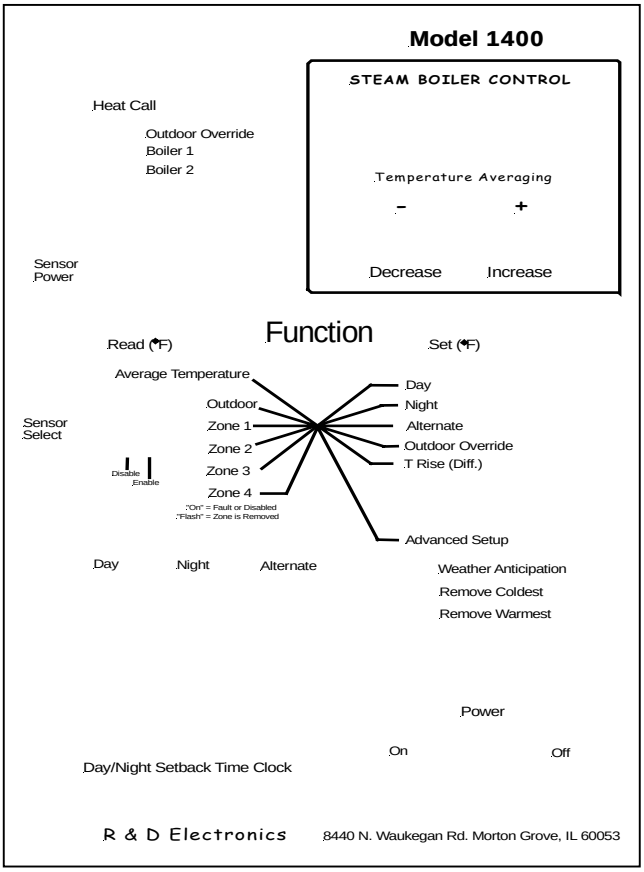
OWNERS MANUAL -- Model RD1402, 1403, 1404
Temperature Averaging Steam Heat Control



The R&D Electronics model RD1400 offers the latest technology in controlling commercial and multifamily steam heated buildings using remote temperature monitoring. Steam piping systems do not distribute heat evenly due to factors such as the length of piping, inadequate venting, improperly sized radiators, etc. Environmental variables such as wind direction, sunlight exposure, building envelope leaks, internal heat sources from lights and utilities, and tenant intervention can all effect room temperatures. Strategically locating multiple sensors throughout the building provides the most reliable and accurate temperature control for widely varying conditions.

The R&D Electronics Model RD1400 consists of a main panel, up to 4 remote indoor sensors, a setback timer, and an outdoor temperature sensor. The main panel has 12 LED which indicate all important ON/OFF operating conditions, including heat call, 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.

Model Number Information: RD1400 printed on the panel is the generic number for the product series. Turn power OFF, then ON**. T**he LCD display digit to the left of the decimal point is the number of indoor sensors that will be supported, and also the last digit of the model number. The digit to the right of the decimal point refers to the software version. *An RD1402 or RD1403 panel may be returned to the factory for upgrading to three or four indoor sensors.*

Function Switch: Rotate the Function switch to READ °F. to monitor average building temperature, outdoor temperature, and indoor zone temperatures 1 thru 4 (determined by model number). Rotate the Function switch to SET °F. to read and adjust the operator setpoints. *The function switch may be left at any position without affecting control operation.*

Control Operation: If the outdoor temperature is below the OUTDOOR OVERRIDE setpoint, and the building AVERAGE TEMPERATURE falls below the building setpoint, the heat call circuit will close. The DAY, NIGHT, or ALTERNATE operator adjustments determine the building setpoint. The ALTERNATE setpoint is optional and requires an *external* time clock kit available from the factory. The *internal* Day/Night Time Clock selects either of two set periods, DAY ("On" displayed within timer) or NIGHT ("Off" displayed within timer). After the average temperature rises the amount of the differential or T-RISE, the heat call circuit will open.

SENSOR SELECT mini rocker switches 1-2 on model RD1402, or 1-2-3-4 on model RD1404 can permanently disable a zone sensor from being included in the building average temperature. The mini rocker switch labeled "Outdoor" can be used to disable the OUTDOOR OVERRIDE function. If a zone sensor reading is below 55 °F. (most likely caused by an open sensor wire) or above 97 °F. (most likely caused by a shorted sensor wire), the respective LED fault indicator turns "ON". The defective sensor will be excluded from the average building temperature.

Advanced Setup: Item 1. WEATHER ANTICIPATION, (usually set to 0.5 to 2.0 °F.) allows a building setpoint increase (outdoor reset) as outdoor temperature decreases. At -10 °F. outdoors, the amount added to the DAY, NIGHT, or ALTERNATE setpoint becomes equal to the weather anticipation value. At 30 °F. outdoors, the building setpoint is increased only ½ this amount; and at 70 °F. outdoors, the increase is zero.

Items 2 and 3. One or both REMOVE WARMEST and REMOVE COLDEST options may be selected on models RD1403 and RD1404. With the model RD1402, only one sensor can automatically be removed from the average. *An LED will flash identifying the warmest and / or coldest sensor. The dual flash repeats at a 4 second interval.* The microprocessor program will remove only the warmest in case there is only one sensor left working,

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 allows programming the entire week using only 2 of 6 available schedule periods. If an optional *external* Alternate Timer is installed, the most common schedule is for an Alternate Setpoint 1 to 3 °F. lower than the Day Setpoint (MO thru FR) from 9:00AM to 3:00PM, or 1 to 3 °F. greater than the day setting (MO thru FR) and (SA SU) from 4:00PM to 9:00PM. Battery backup will keep the setback timers running for 4 months without power. *For best results, replace clock battery every 3 years. To prevent damage to the circuit board, use only Ni-Cad or NiMH batteries.*

DESIGN HIGHLIGHTS

* Motorola MC68HC11 operates in single chip mode. Internal ram, rom, and eeprom

* Operator setpoints are retained in eeprom (permanent memory)
* Includes (1) one outdoor, (2, 3 or 4) indoor zone sensors
* Warm Weather Shutdown or outdoor cutoff
* Monitors actual building temperatures
* Select sensors individually for inclusion in the average building temperature
* Automatically removes the warmest, coldest, or both extreme sensors
* Corrects the desired building temperature setpoint for extreme weather conditions
* Panel LED's indicate which sensors are not functioning
* Average temperature protected against sensors faults
* 3 digit LCD Display
* Setback Timer Weekend/Weekday programmable with 4 mo. battery reserve
* Includes a 2nd relay contact to operate a combustion air damper or second boiler
* Manual bypass switch operates an emergency backup device connected to field wiring board
* Plug-in panel for quick service *without having to disconnect field wiring*
* 16 Gauge steel enclosure with means for a small padlock.

OPERATOR ADJUSTMENT

1 DAY TEMPERATURE SETPOINT: {72}

The RD1400 maintains an average building temperature, although the maximum or minimum worst case room temperatures may vary greatly. Usually, the average day temperature must be set between 72 and 76 degrees to assure that all locations will receive enough heat. The more closely a building is balanced, the lower you may set the average day temperature. Keep in mind that air infiltration may cause floors to be 2-4 degrees colder than temperatures measured at the heat sensors mounted 5 feet above the floor.

2 NIGHT TEMPERATURE SETPOINT: {68}

The amount of night setback is a compromise between fuel savings, and comfort. During an 8 hour night setback period, a setback of 3 and 5 degrees will save nearly as much fuel as a 10 degree setback, and cause less discomfort.

3 ALTERNATE TEMPERATURE SETPOINT: {70 to 78}

Typically used as a 5-day Monday thru Friday setback from 9AM to 3PM, or a 7-day boost from 4PM to 9PM. The setback or boost is usually no greater than 1 to 3 °F.

*4 OUTDOOR OVERRIDE (*or Warm Weather Shutdown) *{55}*

50 F. to 60 F. works well in most buildings.

5 T-RISE (differential): {1.0}

A typical T Rise setting is 1.0 °F. In order to determine the most efficient T Rise setting, you will need to experiment. If your setting is too low, short cycling will result. The boiler will turn off too soon, leaving radiators at the far end of the building only half full of steam. If your setting is too high, unnecessary overshoot and too much time between heating cycles can result.

MANUAL BYPASS PROCEDURE

1) Turn power switch OFF. 2) Open panel door and locate labels describing the orientation of the bypass switches. 3) SW1 operates relay-1 or boiler-1 in conjunction with a manual bypass device connected to MAN BYP terminals. 4) SW2 operates auxiliary device connected to RY2 terminals directly.

ADVANCED SETUP

1 WEATHER ANTICIPATION {1.0}

Increase Weather Anticipation factor if insufficient heat is occurring when it is moderate to very cold outside. Usually, Weather Anticipation is necessary for buildings with poor windows or minimal wall or roof insulation.

Remove Warmest and Coldest Functions.

Models RD1403 and RD1404, allow both the warmest and coldest extreme sensors to be automatically removed from the average building temperature. *The microprocessor will flash the coldest LED indicator, and then .3 seconds later flash the warmest LED indicator and repeat the double flash every 4 seconds*. When set to remove both sensors and only two sensors are working, the microprocessor will remove only the warmest.

2 REMOVE COLDEST {No}

Remove Coldest can safely be used in buildings that are fairly well balanced. It will help protect against open windows. Removing the coldest sensor from buildings that are out of balance may result in short cycling and insufficient heat at the far ends of the building. Removing the coldest is also useful if: 1) you suspect that tenants are tampering with the heat sensors, 2) the risk of under heating is less important than the need for fuel savings.

3 REMOVE WARMEST {Yes}

Set Remove Warmest to {Yes} when having difficulty heating the farthest points from the boiler. This will help force the boiler to run long enough to heat the hardest to reach areas. Remove warmest is also useful if during mid-day periods, the sun heats sensors on the south side of the building, and tenants on the north side are becoming cold.

- Day/Night Timer Programming Procedure --

1. Setting time of day: --

Press and hold key, while the same time press the Day key to advance the day of the week.
Press and hold key, while at the same time press the h+ key (hour increase) for the correct hour.

Press and hold Ⓛ 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 Ⓛ 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

The RD1400 control and remote sensors are factory calibrated; no attempt should be made to perform field re-calibration. It is not reliable to attempting to verify room sensor accuracy while a boiler is cycling on and off. Most digital and mercury test thermometers respond faster to room temperature changes than the RD1400 heat sensors. This causes the thermometer readings to be greater than or less than the readings displayed on the heating control, until the RD1400 sensors “catch up”.

MOUNTING AND WIRING THE REMOTE 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. RUN SENSOR WIRES AT LEAST 6" AWAY FROM TELEPHONE WIRES. You may cross telephone wires, but do not run parallel to phone wires for long distances. The ring signal, under some circumstances, can affect the sensor readings.

2. 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.

3. Do not support sensor wires from hot water, or steam piping. Do not wrap wires around objects, use cable ties to shore up 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.

4. 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.

5. Mount at least 1/3 to 1/2 of the indoor sensors at the far ends of the building, in order that the average temperature readings will represent the colder and harder to heat apartments. Do not place any sensors too near the boiler. If possible, select areas, which are affected differently by the wind and sun. Select larger rather than smaller apartments so that cooking stoves will not cause under-heating. Keep the installation simple and easy to maintain by installing sensors in apartments one above the other (for example top and bottom floors).

6. The indoor sensors should be mounted 5 foot above the floor, and on an inside apartment wall, NEVER ON AN OUTSIDE WALL. Be careful in fire proof buildings, occasionally an inside wall which meets an outside wall can be very cold. DO NOT MOUNT SENSORS TOO NEAR A KITCHEN OR BATHROOM. The sensor should be located at least 10 feet from the nearest radiator; and if possible, on a wall which is adjacent to a closet. Drill a 1/4" hole from the selected wall through the closet in order to pull the wire up from the basement. DO NOT RUN EXPOSED SENSOR WIRE UP THE WALL. SEAL THE 1/4" HOLE BEHIND THE SENSOR SO THAT WALL DRAFTS WILL NOT AFFECT SENSOR READINGS. The sensor wire may go through an outside building wall if necessary.

7. Pull the 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.

8. When connecting sensors, it is most common to specify the white wire as the (-) terminal. In this way, it doesn't matter whether the second wire is black or red. You can always remember that white is negative.

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 control to the boiler.

2. Mount a dedicated 24V AC 20VA power transformer, along with its 120 VAC. power disconnect switch wherever 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.

LOCATING AND MOUNTING THE OUTDOOR CUTOFF 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 will be more that 2" away from the building wall. If an east or west outside wall must be used, be sure that shade is provided by the building itself, or the building next door. **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 near the heat control location.

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.

FIELD SERVICING -- Testing the remote sensors.

MAIN PANEL AND TERMINAL BOARD

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 neces*sary, *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.

Room Sensors: 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 volt meter 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., *similarly the display will read 99.9*, 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 somewhere in the building. If there is an additional system short to conduit ground elsewhere, it will be necessary to trace both shorts before reconnecting the defective sensor line. Two shorts in your system can result in "grounding" 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 follow **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 4 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, *similarly the display reads -199*, then the line is good. If the sensor is good, you will read approx. 12.5Vdc. across the sensor terminals, depending upon the 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 I -- 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

Outdoor Sensor: Connect digital volt meter DVM **(-)** lead to **TS1** terminal 2 [outdoor sensor -)]. Connect DVM (+) to **TS1** terminal 1 [outdoor sensor (+)]. Measure the outdoor sensor voltage and look up the corresponding temperature in Table 2. Replace the sensor if the DVM reading does not correspond with the outdoor temperature. If outdoor temperature reading at the control is not within +/- 2 F. of the value in the look-up table, then replace panel. A wiring short, or a polarity reversal will read -25.5, while a wiring open will read 99.9.

TABLE II -- OUTDOOR SENSOR VOLTAGE TO TEMPERATURE CONVERSION

SENSOR		SENSOR	
Vdc.	°F	Vdc.	°F
2.45	-18.4	2.81	46.4
2.49	-11.2	2.85	53.6
2.53	-4.0	2.89	60.8

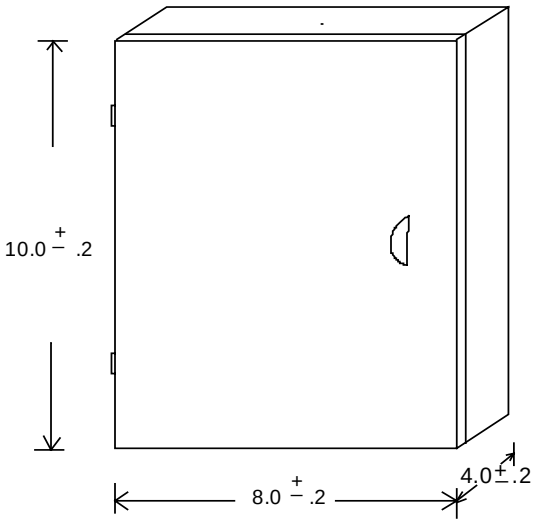
2.57	3.2	2.93	68
2.61	10.4	2.97	75.2
2.65	17.6	3.01	82.4
2.69	24.8	3.05	89.6
2.73	32	3.09	96.8
2.77	39.2	3.13	104.0

ORDERING INFORMATION

Model No.	Product Description
RD1402	2 sensors
RD1403	3 sensors
RD1404	4 sensors
RD101	External Alternate Time Clock kit: (Mounts onto Intermatic ™ T101 series chassis. Plugs into 3 terminal connector on the back of the main panel)

MECHANICAL SPECIFICATIONS

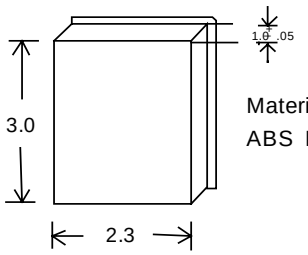
Material : .065 steel



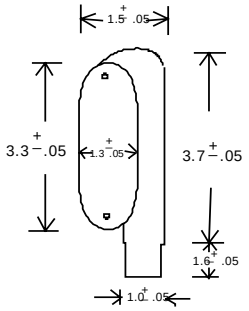
CHASSIS ENCLOSURE

Note : 1 Dimension in inches.

ROOM SENSOR HOUSING



Material :
ABS Plastic



Material :
Aluminum

OUTSIDE SENSOR HOUSING

Electrical Specifications:

Control Accuracy:	+/- .2 °F
Sensor Accuracy:	+/- 1.5 °F
Input Voltage:	24 VAC., .2 amp.
Output Contacts:	N.O. dry, 4 amp., 24 VAC.
Set Temperature Range:	60 to 90 °F
Number of temperature setpoints	(2) on standard model, (3) with optional external clock
Temperature Differential:	.2 to 4 °F
Outdoor Override:	30 to 100 °F
Sensor Type:	integrated circuit, linear output.
Room Sensor Averaging:	separately summed and monitored.
Room Sensor Minimum Range Limit:	55 F. Room Sensor Wiring #18
Room Sensor Wiring:	#18 open paired (unshielded).

RD1400 WIRING DIAGRAM

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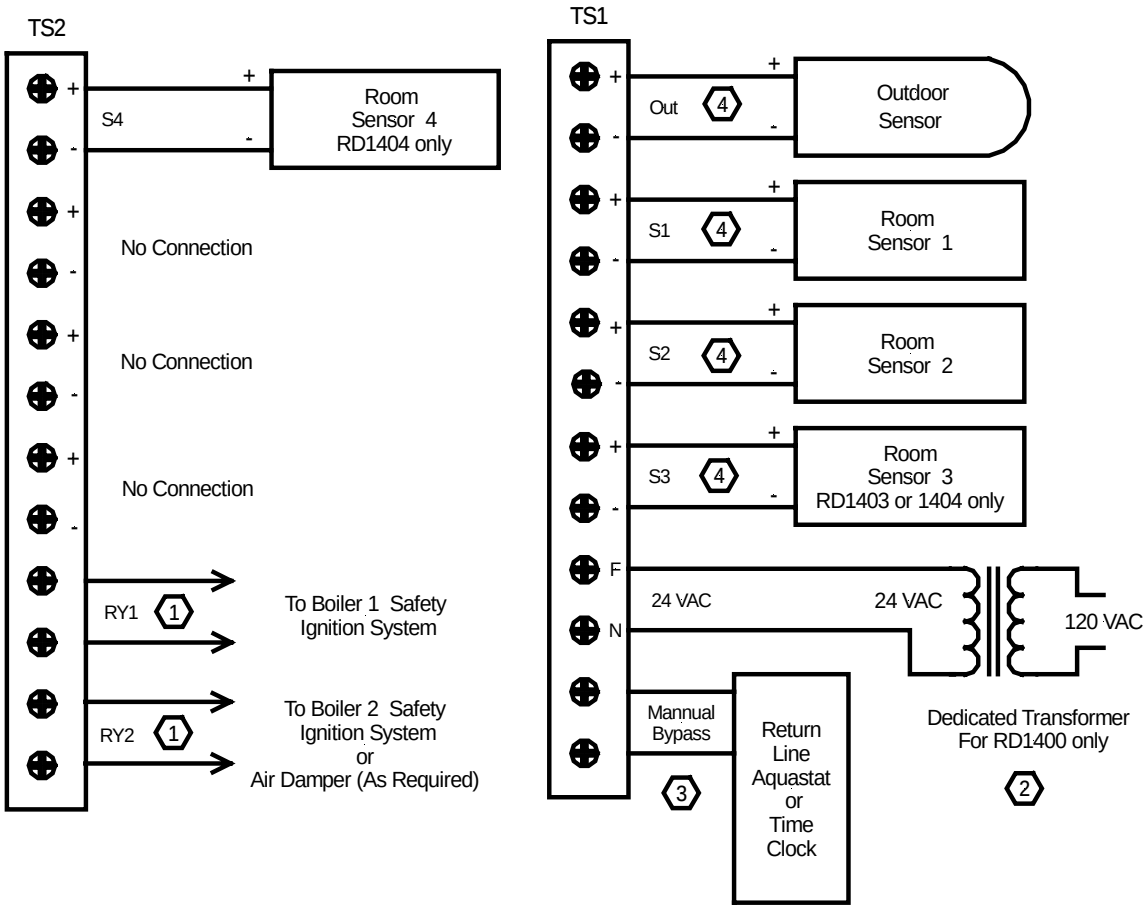

1 Dry Contacts, rated 24 Vac. No power is supplied by the RD1400 to the burner control circuit.

2 Do not power the RD1400 from a RELAY TRANSFORMER MODULE, or from a Transformer that also powers the gas valve.

3 Remove jumper when installing a bypass control such as Aquastat, Time Clock, or Remote Thermostat. Switching from Auto to Manual operates boiler on steam pressure only, unless a bypass control is installed.

4 Use #18 3-cond. thermostat wire or #22 3-cond shielded wire for indoor and outdoor sensors. Shielded wire is more durable but noise immunity built into the sensor designs makes shielding rarely necessary.

Note : RD1430 chassisis may be electrically grounded, but DO NOT GROUND field wiring terminals. Ground only the outdoor sensor "Gnd." terminal.