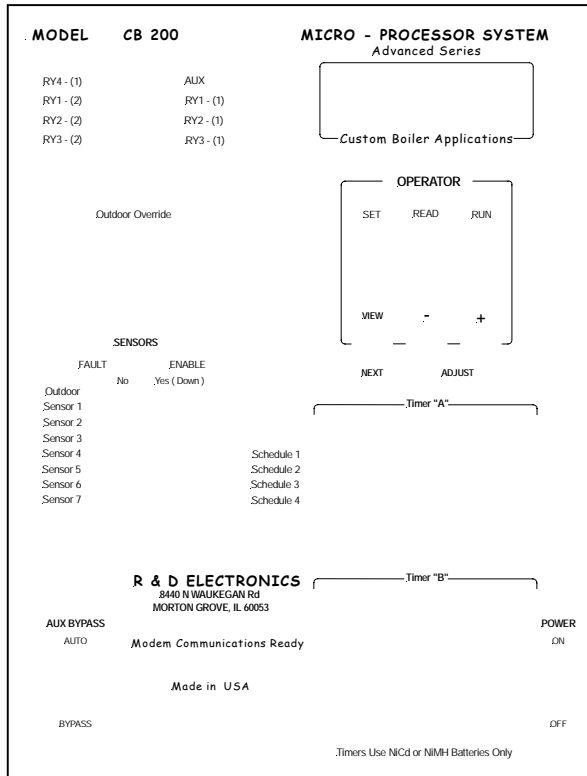


**-- OWNERS MANUAL -- Model CB200 -E2, -E3, -E4  
SP1i - software --- Steam Pressure Control  
-- Full Modulating Burners --**

**FEATURE HIGHLIGHTS**



The **CB200 B** series multi-stage boiler controls are used for small, medium and large cast iron and steel boilers requiring (1) on/off and lo/hi/lo contact closure, (2) a Honeywell™ series 90 135 ohm resistance output, or (3) a 4-20 ma. output. The CB200 can operate up to 4 full modulating or lo/hi/lo steam boilers, or 8 on/off boilers. PI or proportional integral, control provides unmatched energy efficiency.

**GENERAL INFORMATION:**

The R&D Electronics Model CB200 consists of a main panel, a steam pressure sensor, and an outdoor sensor. The main panel has 16 LED's which indicate all important ON/OFF operating conditions, including heat call, sensor faults, and outdoor override. A simple 3 position slide switch labeled SET, READ, and RUN controls the 32 character LCD display menus. The SET menu contains normally used operator adjustments. The READ menu displays outdoor temperature and steam pressure. The RUN menu displays P &

I modulation levels, operating states, and 30 minutes of steam pressure history.

The operator sets the desired steam pressure setpoint, the boiler on/off differential range, boiler interstage lag, proportional start up percent, integral lead, integration rate, outdoor override, and the lead boiler. The Outdoor Override setting (typically 55° F.) programs the warm weather shutdown, which will turn off the boilers and an "aux" relay which could be used to control a boiler room air damper. Sensor LED indicators turn ON if an outdoor sensor fault is detected, or when the 4-20 ma pressure sensor is reading zero pressure. Timer "A" schedules the auto boiler rotation. See Timer "A" programming in a later section of the manual.

Pressure and outdoor sensor fault LED's indicate when there is a sensor failure. ***It is normal for the pressure sensor LED to be ON until there is actual steam pressure.*** To test boiler operation during warm weather, set the outdoor sensor mini rocker switch to "disable" or increase the outdoor override setpoint.

## PROPORTIONAL INTEGRAL "PI" CONTROL:

The lead boiler is called when steam pressure falls below the operator setpoint. The lead boiler will start at a modulation level determined by the *proportional startup* setting. The burner actuator moves towards full open as the boiler pressure decreases. If the *proportional startup* were set to 0%, the actuator will reach full open as pressure decreases by an amount equal to the on/off differential. The *proportional startup* is typically set between 0% and 50% of the on/off differential.

The actuator is also driven by an integral output. If the steam pressure is below the boiler "turn on point", the summed integral output is incremented at a rate determined by the *valve integral rate* (minimum time required to drive the actuator from closed to full open position). The higher the *valve integral rate*, the more the valve position will be effected by the integral settings. The *valve integral lead* determines the integral output equilibrium point. If the steam pressure is below this point, the actuator moves towards open, if the steam pressure is above this point, the actuator moves towards closed. The *valve integral lead* is typically set between 0% and 50% of the on/off differential. It is necessary to experiment to determine the best relationship between "P" and "I" values.

If steam pressure rises beyond the on/off differential, the lead boiler will turn off. On the other hand if steam pressure falls below the operator setpoint by an amount equal to the interstage lag differential, an additional boiler is called. Additional boilers are called each time the steam pressure decreases by the amount of the interstage lag differential. Proportional output resets to *proportional startup* value and the integral output resets to zero anytime boilers are added or removed. Boilers modulate in tandem, at the same modulation level.

## DESIGN HIGHLIGHTS

- \* Motorola MC68HC11 operates in single chip mode. Internal ram, rom, and eeprom.
- \* Modem operation from any PC with standard communications software.
- \* Operator setpoints are retained in eeprom (permanent memory).
- \* Includes (1) one outdoor, (1) 4-20 ma., 0-15 lbs. pressure transducer
- \* Warm Weather Shutdown.
- \* 32 Character backlight LCD Display.
- \* Steam pressure data logging for 30 minutes, 10 sec. resolution.
- \* Auto rotation of boilers either Daily or Weekly.
- \* Auto rotation timer with ni-cad battery back-up and 4 months reserve.
- \* Individual manual bypass switches for all relay outputs.
- \* Variable time delay between successive boiler stage calls.
- \* Plug-in panel for quick service without disturbing the field wiring.
- \* 16 Gauge steel enclosure with means for a padlock

## OPERATOR ADJUST – SET MENU

Place OPERATOR switch in SET. Press VIEW NEXT key. Press + or - to change values.

### TYPICAL SETTINGS:

1 STEAM SETPOINT (PSI) {3.0 to 10.0}

Set to the desired steam pressure within the range of 1 to 12 lbs. The pressure transducer range maximum is 0 to 15 lbs.

2 BOILER ON/OFF DIFF. (PSI) {1.2}

This parameter has two functions. First it represents the difference in steam pressure from boiler "turn on" to "turn off" pressure. Secondly, as steam pressure drops below the "turn on" point by the amount of the on/off differential, the proportional part of the modulation signal sent to the burner actuator increases from 0% to 100%. A lower differential than 1.2 will increase actuator instability and decrease actuator movement resolution.

3 INTERSTAGE LAG DIFF. (PSI) {.6}

If steam pressure were to decrease below the operator setpoint by the amount of the lag differential, a second boiler is called. Additional boilers are called each time the steam pressure decreases the amount of the lag differential. The overall pressure setpoint decreases each time an additional boiler is activated. Increasing the lag differential will increase the accumulated setpoint error, but reduces the frequency of unnecessary boiler operations.

4 PROPORTIONAL START (%) {20%}

A higher *proportional startup* will accelerate the opening of the burner actuator as the steam pressure decreases. Setting this value to 50% results in a proportional output equal to 100% while the steam pressure has decreased only 1/2 the amount of the on/off differential.

5 VALVE INTEGRAL LEAD (PSI) { 0 to (1/2) of (on/off diff.) }

When the steam pressure is above the operator setting + this value, integration results in a gradual closing of the valve. When steam pressure is below this reference, integration causes in a gradual opening of the valve.

6 VALVE INTEGRAL RATE (minutes: seconds) {0:00}

The valve position is determined by the sum of the proportional plus integral outputs. The higher the integration rate, the more the final position of the valve will be boosted by the integration output as opposed to perhaps a slower proportional output only. This value is only an estimate of the time it will take for the motor to drive the actuator from full closed to full open and varies depending upon the actual motor speed.

7 OUTDOOR CUTOFF (Warm Weather Shutdown) {55}

8 SELECT LEAD BOILER { 1, 3, 5, 7 }

At the moment that Timer "A" switches from OFF to ON, the lead stage will be incremented by 2. Run screen 2 displays an "A" for stage 1 and an "H" for stage 8. Only odd numbered entries are accepted by the software. Auto rotation looks like: [1-2, 3-4, 5-6]: [3-4, 5-6, 1-2]: [5-6, 1-2, 3-4].

**OPERATOR MONITORING – READ MENU**

Place the OPERATOR slide switch in READ. Press the VIEW NEXT. The READ menu will display the present steam pressure and the outdoor air temperature

**OPERATOR MONITORING - RUN MENU**

Menu 1 - burner modulation P+I output where 0 is lo fire and 100% is actuator full open; Menu 2 - valve integral or I output only; Menu 3 - output relays and auto rotation timer schedule, [character X] indicates combustion air damper open, [characters ABCDEFGH] represent boiler stages calling for heat, Timer ON signifies for pre-rotation period, Timer OFF represents rotation complete; Menu 4 - Steam pressure data logging.

**CONTRACTOR SETUP:**

(Press plus+ and minus- keys together)

1 BOILER AUTO ROTATION { YES }

YES enables the LEAD STAGE to advance each time Timer "A" changes from off to on state. Normally the timer is programmed to do this early in the morning. The On period can be any length, for example 5 minutes. **Set the timer ON schedule for 4:00AM and the OFF schedule for 4:05AM. Select either a daily or weekly program.** To observe how auto rotation works, you may press the long narrow manual override switch located on the Timer "A". The call LED's will turn on in the newly rotated order. Refer to Timer programming procedure located on the chassis door.

2 BOILER "ON" TIME DELAY { 00:01 to 00:30 }

Set to {0:10} or 10 seconds unless it is necessary to slow boiler reaction time. Increasing the delay will reduce unnecessary boiler operations, but slow the system response to load changes. *To test the boiler system and activate all boilers quickly, set the delay to one second.*

3. # STAGES READY IN SYSTEM { 2 to 8 } Set to 2X

the total number of operational boilers in the system. Data entry is restricted to even numbers.

Each boiler is considered as 2 stages; (1) hi fire activation and (2) burner modulation from hi to lo fire as steam pressure increases.

4. # STAGES IN USE NOW {0 to 2 stages less than item 9 above} Set to less than the total number of operational boilers in the system if you would like one or more boilers to operate on standby only. The standby boilers will automatically come on line only in the event of a failure of the preceding boiler in the sequence. *Set this number equal to the # STAGES READY IN SYSTEM if you do not desire to maintain time delayed standby boilers.*

5. LAST BOILER HOLD FOR BACKUP {60:00}  
Represents the wait period before turning on a standby boiler. If the number of boilers running is unable to maintain the computed setpoint, and the number of stages presently in use are less than the number of stages ready in the system, then the next standby boiler will be activated after this delay period.

6. CONTROL / UNIT PASS CODE {3 2 1}  
Any number between 000 and 999 may be set. When dialing into the heat control over a modem, enter "P" followed by this number to gain access. DO NOT change this number through the modem or you will lose communication.

**Restoring Factory Default Operator and System Settings:** (1) turn Power switch OFF, (2) hold the NEXT key while turning the Power back ON. *Consult your contractor before resetting to factory defaults. Resetting will change items 5-7 in the SYSTEM menu (described above) which are specific to your type of boiler and may impair its operation.*

**Test/Operate Mode:** The mini slide switch on the longer field wiring board is used to limit boiler modulation level to 50%. Use the test mode to (1) easily test the control modulation output and motor actuator operation and (2) limit the maximum modulation level even while under auto operation.

**Manual Bypass:** Turn POWER switch OFF. Place BOILER switch in MANUAL to operate a combustion air damper (if installed). Manual bypass switches for each stage are behind the front panel on the terminal wiring board. Auto position is DOWN, Bypass is UP.

**Timer "A" :** If the Day/Night Timer display indicates ON, control is in Schedule 1 period, whereas OFF is Schedule 2. Timer memory allows 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 4 program steps. The battery will fully recharge in 24 Hrs., and maintain the timer for 4 months. The rechargeable battery receives charging current even when the front panel power

switch is turned off. See instructions on the chassis door for further details. **REPLACE THE NI-CAD BATTERY AT LEAST EVERY 3 YEARS.**

**Notes on 30 minute data logging:** The six displayed numbers are the average of readings every 30 seconds and update every two hours. The min. or max. steam pressure could be +/- .2 lbs. above or below the recorded average values.

*LOCATING AND MOUNTING OUTDOOR and PRESSURE SENSORS*

**Outdoor:** The outdoor sensor housing attaches to a 1/2" electrical conduit pipe which should be mounted VERTICAL, and if possible, 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, a shade must be provided to assure that the sensor never sees direct sunlight. **Do not mount the outdoor sensor on a south wall.**

1. Run #22 or larger 2 cond. shielded wire to the outside sensor location. The shield protects the sensor from static damage.
2. Drill a 3/8" hole in the brick where the outdoor sensor is to be mounted. Chip 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 being cut.
3. Drill mounting holes in the outside brick wall for two #10 plastic anchors for fastening the conduit clamps. The "U" channel clamps are more rigid than the flat clamps and are recommended.  
NAILING THE CONDUIT TO THE BUILDING WALL IS NOT RECOMMENDED.
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 shielded cable to the sensor PC board (+), (-), and (Gnd.) per wiring diagram.
6. Fasten the electrical conduit to the wall using #10 sheet metal screws into plastic anchors or similar.

**Pressure Sensor Troubleshooting:** Connect dvm (-) to outdoor sensor (-), and dvm (+) to pressure sensor (+). Read dvm voltage corresponding to voltage to pressure table below.

**Table 1 -- PRESSURE SENSOR -- Voltage to pressure conversion with 200 ohm load.**

VOLTAGE READING	PRESSURE READING
0.8	0
1.2	1.9
1.6	3.8
2.0	5.6
2.8	9.4
3.6	13.0

**Steam Pressure Sensor:** A WIKA model - ECO-1 0-15 Lbs. pressure transducer @ 4-20 ma. output is shipped with the CB200. A pressure transducer with similar specifications will do the same job. Terminal 1 of the ECO-1 transducer connects to CB200 S2(+), and terminal 2 connects to S2(-) The pressure sensor should be installed according to the same procedures use to install operator and hi limit pressure controls. Data logging of pressure is limited to 9.9 lbs.

### **Outdoor Sensor Troubleshooting:**

**Table 2 -- OUTDOOR SENSOR -- voltage to temperature conversion.**

-20 F = 2.44 V	40 F = 2.77 V
-10 F = 2.50 V	50 F = 2.83 V
0F = 2.55 V	60 F = 2.89 V
10 F = 2.61 V	70 F = 2.95 V
20 F = 2.66 V	80 F = 3.00 V
30 F = 2.72 V	90 F = 3.05 V

Problem: Outdoor sensor warning light is ON. First verify that the enable switch #1 is down in the direction of the word “enable” on the front panel.

1. Connect a digital voltmeter DVM (-) lead to outdoor sensor (-) terminal or common. Connect the DVM (+) lead to the (+) terminal of the pressure sensor. DVM must read 12.8 to 13.8 Vdc. If not true, then the main panel is defective. *Sometimes a (+) lead sensor wire will short to ground elsewhere in the building. If there is an additional system short to conduit ground (such as through a defective 24Vac transformer) it will be necessary to trace both shorts before reconnecting the defective sensor line. Two shorts in your system can result in the “grounding” of the +13Vdc. Isolate each sensor from the terminal board one at a time to locate the second short.*

2. *Test the outdoor sensor input:* Connect the DVM (-) lead to the outdoor sensor (-) terminal or common. Connect the DVM (+) lead to the outdoor sensor (+) terminal. Verify the dvm reading by looking up the voltage in **Table 2**, the sensor voltage to temperature chart.

3. *Testing for reversed sensor polarity and shorted lines:* If in the above step 1 the DVM reads 12 to 13 Vdc, then the sensor wiring is either shorted, or the sensor polarity is reversed. Try disconnecting the sensor and reversing the wiring polarity.

CB200 -B modulation output test (performed at field wiring terminal boards)

Note: To perform this procedure during summer, disable outdoor cutoff from outdoor select rocker switch, or by increasing the outdoor override setpoint.

The actuator driver boards provide 4-20 Ma., or 135 ohm simulation for Honeywell (T.M.) series 90 motor actuators. See identification label on driver board.

1) Before connecting the CB200 -B to a motor actuator, connect a DVM between W-R, and B-R at the motor actuator and verify +19 Vdc. open circuit motor actuator output. Next, momentarily short R to B and verify the motor actuator opens fully. Connect motor actuator W-R-B wires to correct terminals on CB200.

2) Set the Operator switch to READ and note the boiler water temperature. Go to the System Initial Setup Menu (press + and - keys simultaneously) and set *item 3*, the Absolute Minimum Water Temperature such that it is 40° F. above the boiler water temperature. Set *item 5*, the Boiler On Time Delay to 5 sec., *item 6*, the PID sample Rate to 5 sec., *item 7*, Burner Modulation Rate to Fast. *This is the high speed test mode*, forcing the CB200 to quickly turn on boiler stages and begin modulation.

3) Connect dvm (-) lead to W-R-B terminal R, your measurements will be on the smaller driver boards. Turn the CB200 control ON, and stage 1 will turn ON immediately. Wait for stage 2 (release to modulation) to turn ON, and continue waiting until the modulation level (Run menu item 3) reaches 100%. a) Verify that the voltage across W-R is 2.1 to 2.3 Vdc. b) Verify that the voltage across B-R is 1.5 to 1.7 Vdc. c) Verify that the motor is at full open position.

4) Place the *test / operate* mini slide switch on the long narrow wiring board to the *test* position. a) Verify that the voltage from W-R = 1.5 to 1.7 Vdc. b) Verify that the motor stops at the ½ open position. Return Test/Operate switch to Operate. Turn the CB200 Power switch momentarily Off then back On, resetting the modulation level to zero. Verify that voltage from W-R is .8 to 1.0 Vdc. before modulation starts. **Note:** For 135 ohm simulation,

B-R voltage remains constant at approx. 1.6 Vdc. W-R voltage varies from approx. .90 Vdc. (lo fire) to 2.2 Vdc. (high fire).

5) RETURN SYSTEM MENU TO NORMAL SETUP. a) *Item 3*, Boiler Water Absolute Minimum Temperatures. b) *Item 5*, Boiler ON Delays. c) *Item 6*, Boiler PID Sampling Rate. d) *Item 7*, Burner Modulation Rate.

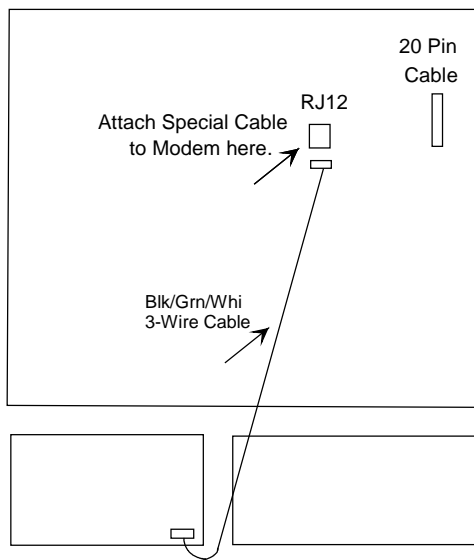
**In case of difficulty:** *Test the front panel and the long narrow field wiring board.*

1) Connect d.v.m (-) to "N" terminal (lower terminal from 24 Vac Transformer). Connect d.v.m. (+) to the test pin soldered to resistor R1 just below the black relay Ry-1. Turn the CB200 power switch momentarily Off then back On, resetting the modulation level to zero. Verify that the voltage at test point steps every 5 seconds as follows: 0 Vdc., .5 Vdc., 1.0 Vdc., 1.5 Vdc., 2.0 Vdc. 2.5 Vdc.

2) If the control *fails* step 1 above, then the trouble is in either the front panel, the long narrow field wiring board, or the interconnect cable. If the control *passes* step 1 above, the trouble is in the 4-20 ma. or 135 ohm driver boards.

[Note: If the Burner Modulation Rate were set to Slow instead of Fast, the test point voltage will step only .17 Vdc (170 mv) every 5 seconds and take 3 times as long to reach 100% modulation]. The burner modulation rate determines the amount of motor movement, and the sampling rate determines the time in-between motor movement steps.

## MODEM INSTALLATION AND OPERATION



Typical installation time for the modem kit is under 15 minutes, provided that there is an existing telephone jack nearby. For help with Hyperterminal™ consult with factory. R&D Electronics supplies free telephone technical support for a period of three years. We will guide you over the phone on how to set up your existing Windows Hyperterminal™ communications program.

Any communications program such as Microsoft Hyper-Terminal, Works, or Procomm™ will work with our pre-initialized modem. Use the special cable provided from the 25 pin RS232 port on the modem to connect to the 6 pin modular jack on the CB200 series control. (1) Choose a name and setup a new dial-up connection. Data will be sent to the PC in the same format shown on the heating control's 32 character LCD. (2) Set your PC Modem Baud Rate to 9600 N, 8, 1. All functions are available through the modem except programming the time clock, and disabling individual zone sensors. The following numeric computer keys will emulate the one slide switch and the three key switches on the CB200 series front panel:

1 = SET	4 = SYSTEM	ENTER = NEXT
2 = READ	(+) = INCREASE	
3 = RUN	(-) = DECREASE	

The R&D Electronics modem kit includes a Zoom™ model 2948 or 2949 external modem, two R&D Electronics custom cables, one connecting the microprocessor board to the RJ12 connector on the main panel board, and a second cable connecting the RJ12 connector on the main board to the Zoom™ modem. The Zoom™ modem is then connected to the telephone line using a standard RJ11 cable that comes with the modem. *There are no additional wiring requirements other than supplying 120 Vac power to the modem power module.*

### ORDERING INFORMATION

<u>Application</u>	<u>No. of Boilers</u>	<u>No. stages</u>	<u>Product Model Number</u>
Full Modulation*	2, 4, 6	4, 8, 12	CB200 E2, E3, or E4
ON/OFF	4, 8, 12	4, 8, 12	CB200 G4, G8, or G12
Lo/Hi fire	2, 4, 6	4, 8, 12	Same model as above

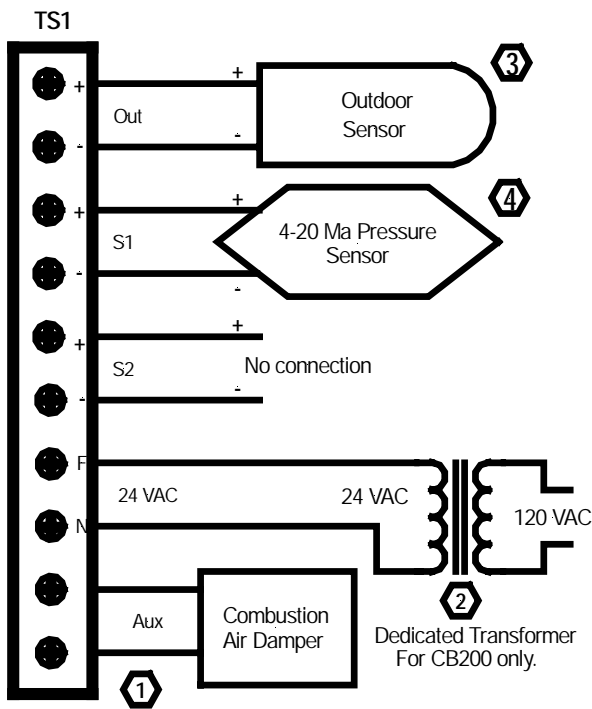
Consult factory for on matching the type of motor actuator for your application. The field wiring circuit boards consist of a motherboard, plus one to three 4-stage plug-in modules. \* Lo fire is considered as a stage-1, modulation as stage-2.

#### Electrical and Mechanical SPECIFICATIONS:

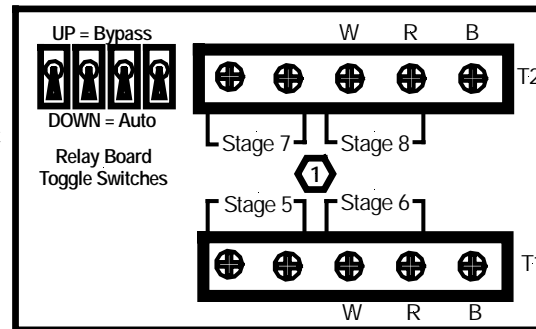
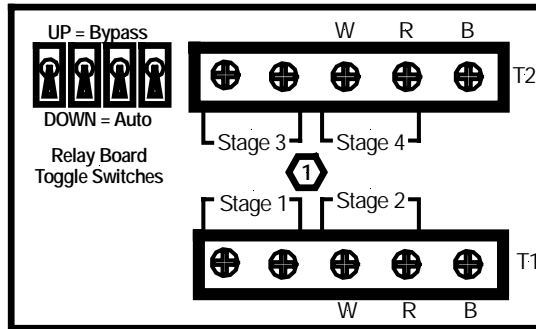
Control accuracy:	.5 F.	Enclosure:	NEMA 1 10 X 10 X 4
Outdoor sensor accuracy:	+/- 2 deg. F.		16 Gauge Steel.
Output switching:	24 Vac 5 amps.	Sensor field wiring:	#20 2 cond. shielded.
Pressure sensor range:	0 to 15 lbs. Wika ECO - 1	Auto rotation schedule timer:	2 month battery reserve.
Outdoor temp. range:	-27.5 to + 100 F.		programmable for 5 day (Mo-Fr) and 2 day (Sa-Su)
Actuator interface:	Honeywell 135 ohm or 4-20 Ma.		grouping, or individual days.
Boiler staging:	Proportional Lead/Lag		

# CB200 -G4,8,12 and -E4,6,8,12 -- WIRING DIAGRAM

ISSUE "A" 9-16-04



Use 2 cond. shielded wire for "W-R-B", "R" is shield.



Use 2 cond. shielded wire for "W-R-B", "R" is shield.

### Numbered reference notes:

1. All relay contacts are dry, and rated at 24Vac.
2. Transformer must only supply power to the CB200, no other devices.
3. Connect outdoor sensor shield (if used) to electrical ground, for best protection against lightning.
4. Wika ECO-1 4-20 Ma sensor, 0-15 PSI, terminal 1 (+), terminal 2 (-).

### Other notes:

1. CB200 Chassis may be electrically grounded, but DO NOT GROUND field wiring terminals.
2. Connect field wiring from actuators "W-R-B" to control with 2-conductor shielded, "R" wire is shield.  
Do not run W-R-B wiring inside electrical conduit containing 120 Vac wiring also.
3. "-G" models used for on/off applications, "-E" model used for full burner modulation.