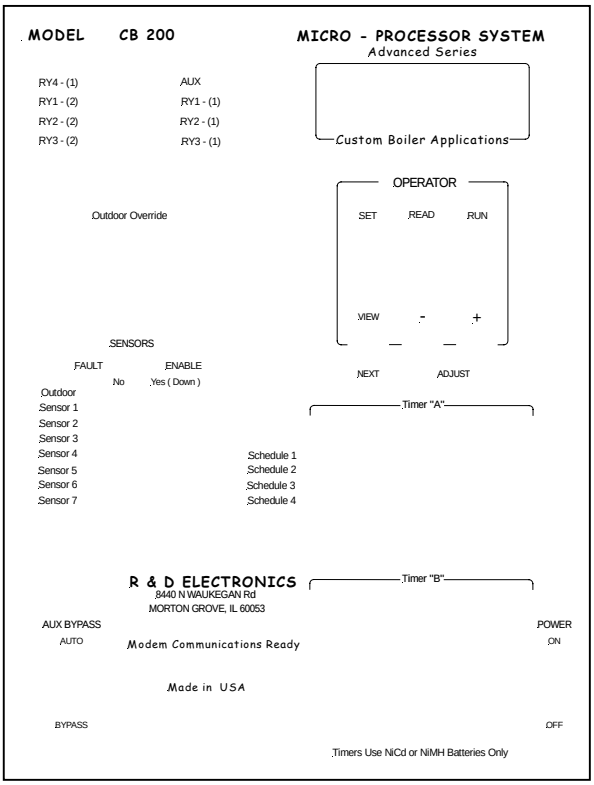
-- OWNERS MANUAL -- Model CB200 -G4 and -G8
SP2a - software --- Steam Pressure Control
-- On/Off - Lo/Hi/Lo Multiple Boilers --

FEATURE HIGHLIGHTS



The **CB200 G** series multi-stage boiler controls are used for small, medium and large cast iron and steel boilers requiring on/off and lo/hi/lo contact closure, 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 calculated pressure setpoint, 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, lo fire lead differential (lo fire setpoint), outdoor override, and the lead boiler. The Outdoor Override setting (typically 55^{o} F.) programs the warm weather shutdown, which will turn off all the boilers and an "aux" relay which could be used to control a boiler room air damper. Sensor LED indicators are ON if an outdoor sensor fault is detected or when the pressure sensor reading is zero. Timer "A" schedules when boiler auto rotation takes place. See Timer "A" programming in a later section instructions.

Pressure and outdoor sensor fault LED's indicate when there is a sensor failure. ***It is normal for the pressure sensor fault 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.

BOILER SEQUENCING LOGIC

Resulting relay states as pressure decreases and then increases.

ON/OFF applications:

Boiler (1) call occurs when steam pressure *decrease*s to: [ry-1 closed ; ry-2 open]
(operator setpoint).
Boiler (2) call occurs when steam pressure *decreases* to: [ry-1 closed ; ry-2 closed]
(operator setpoint) – (lag differential).
Boiler (2) turn off occurs when steam pressure *increases* to:[ry-1 closed ; ry-2 open]
(operator setpoint) – (lag differential) + (on/off differential)
Boiler (1) turn off occurs steam pressure *increases* to: [ry-1 open ; ry-2 open]
(operator setpoint) + (on/off differential).

LO/HI/LO applications:

Boiler (1) hi fire call occurs when steam pressure falls below:
(operator setpoint).
[ry-1 closed; ry-2 open]
Boiler (1) lo fire call occurs when steam pressure *increases* to:
(operator setpoint) + (lead differential).
[ry-1 closed; ry-2 closed]
Boiler (1-2) hi fire occurs when steam pressure *decreases* to:
(operator setpoint) – (lag differential).
[ry-1 closed; ry-2 open] [ry-3 closed; ry-4 open]
Boiler (1-2) lo fire occurs when steam pressure *increases* to:
(operator setpoint) - (lag differential) + (lead differential).
[ry-1 closed; ry-2 closed] [ry-3 closed; ry-4 closed]
Boiler (1) hi fire occurs when steam pressure *increases* to:
(operator setpoint) - (lag differential) + (on/off differential).
[ry-1 closed; ry-2 open] [ry-3 open; ry-4 open]
Boiler (1) lo fire occurs when steam pressure *increases* to:
(operator setpoint) + (lead differential).
[ry-1 closed; ry-2 closed]
Boiler (1) turn off occurs when steam pressure *increases* to:
(operator setpoint) + (on/off differential).
[ry-1 open; ry-2 open]

DESIGN HIGHLIGHTS

* Motorola MC68HC11 operates in single chip mode. Internal ram, rom, and eeprom.
* Modem operation from any PC with standard communications software.
* Most self diagnostic sequencing algorithm on the market.
* Displays pressure breakpoints that indicate when stages turn on and turn off.

* Operator setpoints are retained in non-volatile 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 to15 lbs.

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

Represents the difference in steam pressure from a boiler "turn on" to a boiler "turn off". As the steam pressure increases or decreases by more than the on/off differential, the number of boilers in operation will increase or decrease. A higher on/off differential setting will result in fewer changes in the number of boilers in operation (as the steam load changes). Setting the differential lower will maintain a tighter control over pressure. Therefore, choosing an on/off differential setting is *a tradeoff between attempting to maintain a constant number of boilers in operation or a more steady steam pressure*. In most cases a 1 or 2 lbs. variation in steam pressure has no significant effect upon heat distribution.

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

If steam pressure were to decrease below the boiler stage setpoint (which changes with the number of boilers in operation) by the amount of the lag differential, the next boiler will turn on, and all boilers in operation will revert to hi fire. Additional boilers are called each time the steam pressure decreases the amount of the lag differential, resulting in lower steam pressure setpoints as more boilers turn on. Therefore, choosing an interstage differential is again a tradeoff, but this time between attempting to maintain a constant number of boilers in operation or allowing the steam pressure setpoint to decrease each time an additional boiler is required.

4 LO FIRE LEAD DIFFERENTIAL (PSI) {.6}

Typically set to ½ the on/off differential. If steam pressure increases the amount of the lo fire lead differential, all even numbered lo fire output relays close, activating lo fire for all boilers currently in operation. As a result the net BTU firing rate decreased. The "lo fire ***lead*** differential" setting is a complement to the familiar term "interstage ***lag*** differential" which determined the steam pressure setpoint below which the net BTU firing rate increased.

5 OUTDOOR CUTOFF (Warm Weather Shutdown) {55}

6 SELECT LEAD BOILER {1, 2, 3, 4} lo/hi {1, 3, 5, 7} on/off

At the moment that Timer "A" switches from OFF to ON, the lead stage will increment.

Note: Run screen 2 displays an "A" for stage 1 and an "H" for stage-8. When control is set for lo/hi/lo applications, 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] for lo/hi applications.

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 – Pressure setpoint below which *starts* the next boiler; Menu 2 – Pressure setpoint above which either *starts* lo fire or *stops* "last stage on" stage; 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 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 STAGE ROTATION SEQUENCE {ON/OFF or LO/HI/LO}
Application function setup for operating multiple on/off or multiple lo/hi/lo boilers.

3 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 decrease system response time to load changes. *To test the boiler system and activate all boilers quickly, set the delay to one second.*

4. # STAGES READY IN SYSTEM { 2 to 8 }
Set to 2 times 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.

5. # 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.*

6. 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.

7. 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.*

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. Lo/hi/lo boilers are operated in relay pairs. *Activate an odd numbered relay* for hi fire, and activate both the *even and odd numbered relay pair* to set a lo/hi/lo boiler in lo fire.

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 5 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 when running outdoor sensor wire longer than 100 ft. 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 - EC0-1 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. Pressure data logging; readout is limited to 9.9 lbs. **The pressure sensor fault light will remain ON unless steam pressure is greater than .2 lbs.**

Outdoor Sensor Troubleshooting:

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

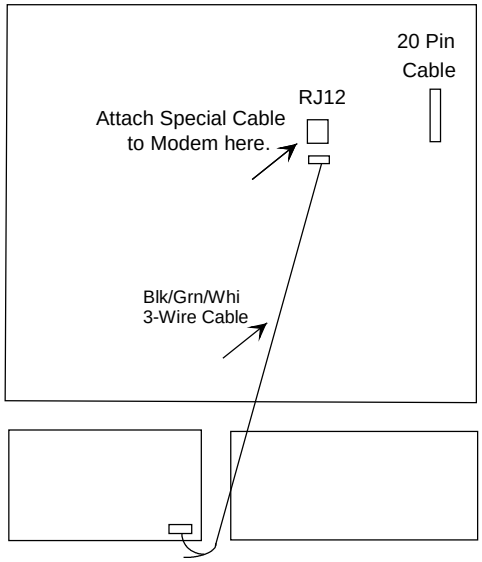
-20 F	= 2.44 V	40 F	= 2.77 V
-10 F	= 2.50 V	50 F	= 2.83 V
0F	= 2.55 V	60 F	= 2.89 V
10 F	= 2.61 V	70 F	= 2.95 V
20 F	= 2.66 V	80 F	= 3.00 V
30 F	= 2.72 V	90 F	= 3.05 V

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**.**



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 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

Application	No. of Boilers	No. stages	Product Model Number
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.
Control power: 24Vac
Outdoor sensor accuracy: +/- 2 deg. F.
Output switching: 24 Vac 5 amps.
Pressure sensor range: 0 to 15 lbs. Wika ECO - 1
Outdoor temp. range: -27.5 to + 100 F.
Boiler staging: Proportional Lead/Lag

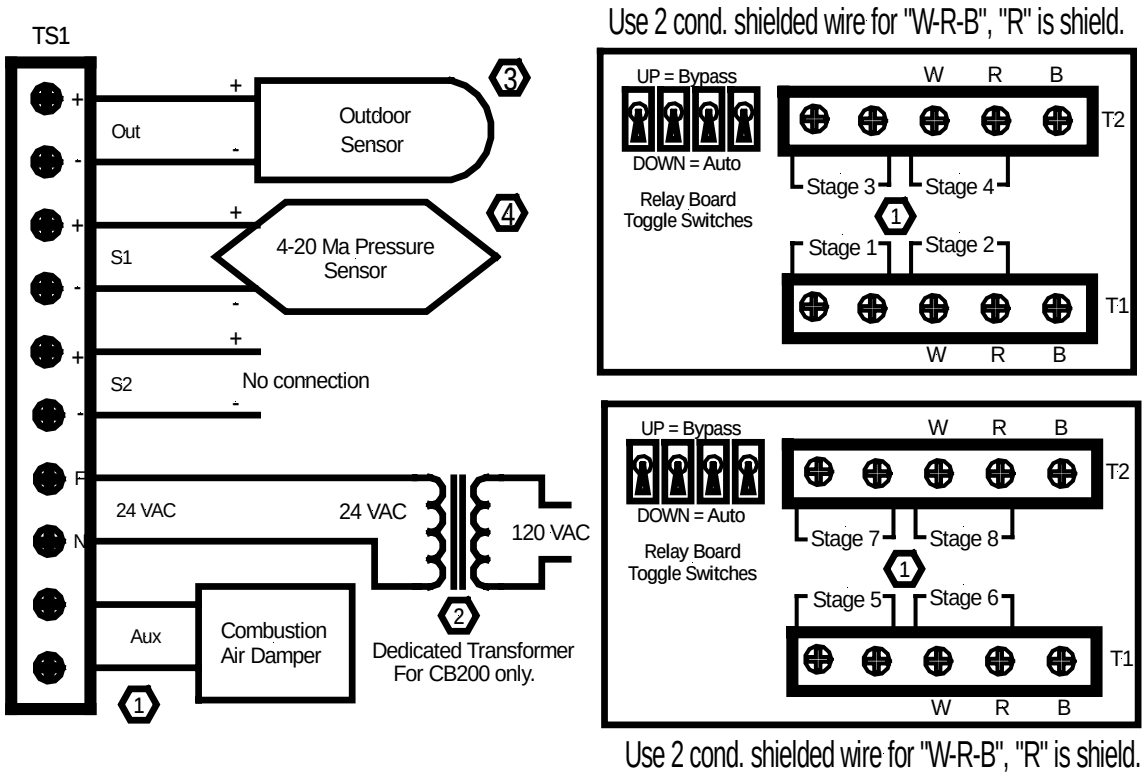
Enclosure: NEMA 1 10 X 10 X 4
16 Gauge Steel.
Sensor field wiring: #20 2 cond. shielded.
Auto rotation schedule timer: 2 month battery reserve.
programmable for 5 day (Mo-Fr) and 2 day (Sa-Su) grouping, or individual days up to six.

4 STAGE CONTROL mounted in NEMA 1, 8 x 10 x 4 steel hinge cover chassis.

8 STAGE CONTROL mounted in NEMA 1, 10 x 12 x 4 steel hinge cover chassis.

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

ISSUE "A" 9-16-04



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 lightening.
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.