

---

# INSTALLATION INSTRUCTIONS

---

## ENERGY MANAGEMENT CONTROLLER

**Model**  
**CS2000A**



**CLIMATE CONTROL SOLUTIONS**

Bard Manufacturing Company  
Bryan, Ohio 43506  
*Since 1914...Moving ahead just as planned.*

Manual : 2100-454F  
Supersedes: 2100-454E  
File: Volume III Tab 19  
Date: 03-31-06

## Operation Overview

The CS2000A is an energy management controller that works in conjunction with a non-programmable HVAC (air conditioner or heat pump) thermostat to optimize energy savings and occupant comfort. The CS2000A's learning capability, occupancy detection, and self-adjusting time-base provides effective control of HVAC systems without the need for user adjustments. There is no time clock to set or adjust as the controller automatically learns the occupancy pattern by observation and programs itself accordingly, and then automatically adapts to any schedule changes or unplanned occupancy. Simply stated, the CS2000A gives authority to the room thermostat in advance of learned first arrival to precondition the space and also during occupied periods. During unoccupied periods, the CS2000A monitors room temperature through its built-in thermistor and gives temporary authority back to the room thermostat long enough to maintain the selected set-back or set-up temperature condition selected within the CS2000A. Additional control features of the CS2000A include the ability to operate ventilation and lighting of the same conditioned space.

### Model CS2000A General Specifications

#### Inputs/Outputs

|                             |                           |
|-----------------------------|---------------------------|
| Power Supply                | 10-30 VAC or VDC (<100ma) |
| HVAC Relay (pilot)          | Form C, 24VAC, 3A Max.    |
| HVAC Fan Relay (pilot)      | Form C, 24VAC, 3A Max     |
| Vent Relay (pilot)          | Form B, 24VAC, 3A Max     |
| Area Occupied Relay (pilot) | Form C, 24VAC, 3A Max     |

#### Installer Interface

|                        |                      |
|------------------------|----------------------|
| Function Selection     | 10 PCIB DIP Switches |
| Temperature Set Points | 10 PCIB DIP Switches |
| Indication             | Single LED           |

#### Physical Characteristics

|                       |                                                        |
|-----------------------|--------------------------------------------------------|
| Operating Temperature | 0 to 122F (-20 to 50C)                                 |
| Case                  | 2-piece, 4 x 5.375 x 2 in., high impact ABS, UL Listed |
| Color                 | Off-White                                              |
| Terminals             | 12-22 AWG, #3 screw                                    |
| Mounting              | 4 screws                                               |

### Installation and Location Selection

One CS2000A is typically used to control a single HVAC unit conditioning a single space such as a classroom. The CS2000A should be mounted about 7 feet from the floor and centrally located on the wall such that it can "view" the largest central core area of the space. Judgment is required to select the most suitable location. For rectangular spaces, it is recommended to place make a center placement on one of the short walls for maximum sensitivity. Also take into consideration where the room entry door(s) are, especially if the controller is also to be used to control lighting. Avoid corners (unless mounted on an angle) and anything that may block the controller's line of sight to the main area of the room where the principal activities occur. If possible, give consideration to where the instructor's desk will be, although this can change from room to room and is dependent upon each individuals preference. There may be instances when only the instructor is present that they may be "out of view" for the search time (typically 30 minutes) and this can cause the system to go into unoccupied mode requiring presence to be redetected by instructor passing through detection zone.

**See additional details on pages 11 and 12.**

### Model CS2000A Features

|                                |                                        |
|--------------------------------|----------------------------------------|
| Motion Sensor                  | Internal long-range PIR                |
| Temperature Sensor             | Internal thermistor                    |
| Learning                       | Daily and weekly schedule              |
| Optimal; Start-Up              | First morning wake-up                  |
| HVAC Systems                   | Air conditioners and heat pumps        |
| Auxiliary Equipment Controlled | Lighting                               |
| Access Mode                    | With or without door switches          |
| Setback Temperature Range      | 48 to 68F                              |
| Setup Temperature Range        | 78 to 90F                              |
| Demand Delay                   | Random time after start-up             |
| Recovery Rates                 | Economy or comfort                     |
| Search Times                   | 5, 15 or 30 minutes                    |
| Adaptive Freeze Protection     | 48 and 54F                             |
| External Pre-Condition         | 3 hours                                |
| Temperature Clamps             | 67 and 79F                             |
| Short Cycle Protection         | 3-minute off (minimum)                 |
| HVAC Problem Detection         | Temperature threshold                  |
| Computer Watchdog Timer        | Auto restart                           |
| HVAC High-Temperature Shutdown | 122F                                   |
| Manual Override                | Resets after 24 hours                  |
| Power Fail Sense               | Detects AC outage                      |
| Learned Schedule Retention     | 30 minutes minimum                     |
| Maid Control                   | 2 <sup>nd</sup> set of temps for sleep |

### Wiring Connections

All wiring to the CS2000A from the thermostat and HVAC system should be 18-gauge suitable for any applicable codes. See the appropriate connection diagrams for the HVAC equipment being controlled.

Vent, HVAC Fan, and Area Occupied control outputs are available in addition to the primary HVAC output used to enable the room thermostat. This can be used as shown or ignored based on the installation requirements.

Note 1: The HVAC Fan output must be used to assure continuous fan (blower) operation during the occupied periods (in case someone switches Fan switch on thermostat to "auto").

Note 2: If the Area Occupied output is to be used for lighting control a lighting control relay or contactor with NC (normally closed) contacts sized to the lighting load must be used as shown on the connection diagrams. The Area Occupied relay output on board the CS2000A is pilot duty only, and must be used to slave the field supplied lighting control device.

Note 3: PRECOND connections on CS2000A not used.

Note 4: DOOR connections are not typically used.

See Function Switch #3 – Mode, for details.

## FUNCTION SWITCH SETTINGS

The CS2000A Energy Monitor Controller operation is governed by the settings of the 10 function switches as shown below:

1. Learn (LRN) **Left = Anticipate (Factory default setting).** CS2000A learns occupancy schedule for each day of week  
**Right = Non-Anticipate.** CS2000A operates on occupancy only.
2. Pre-Purge (PRE P) **Left = Activate Vent and HVAC Fan output upon first arrival (Factory default setting).**  
**Right = Pre-purge for 1 hour.** Vent and HVAC Fan outputs are turned "On" for 1 hour in advance of learned arrival time.
3. Mode  

See Bottom of Page 3

  
**Left = Limited.** Requires door switches on all entry/exit doors.  
**Right = Unlimited (Factory default setting).** Control is based upon motion sense only.
4. Rate  
**Left = Economy.** Maximum energy savings, no wait after recovery before returning to setback/setup settings if occupancy doesn't occur on schedule, lower heat strip usage.  
**Right = Comfort. (Factory default setting).** Maximum comfort level, 30-minute wait after recovery before returning to setback/setup settings if occupancy doesn't occur on schedule, higher heat strip usage.
5. Time  
**Left = Short.** 5 minutes for limited access, 15 minutes for unlimited access.  
**Right = Long (Factory default setting).** 15 minutes for limited access, 30 minutes for unlimited access.
6. N/C  
**Left = Do not use.**  
**Right = Required setting (Factory default setting).**
7. Stage  
**Left = HVAC (Thermostat) control (Factory default setting).**  
**Right = Do not use.**
8. Aux  
**Left = Area occupied output—used for lighting control (Factory default setting).**  
**Right = Do not use.**
9. DMD 2  
**Left = 100% duty cycle (Factory default setting).**  
**Right = Do not use.**
10. DMD 1  
**Left = 100% duty cycle (Factory default setting).**  
**Right = 80% duty cycle 15 minutes "On", 4 minutes "Off".**

## FUNCTION SWITCH SETTINGS

**Basic Temperature Settings.** Setting of the temperature switches determines the set-up and set-back temperatures that the CS2000A controls to during unoccupied periods. A minimum of two (2) switches must be "On" ----- one for set-up and one for set-back. Factory default settings are 84 and 62F, and offer a reasonable compromise between energy savings and comfort.

**Adaptive Freeze Protection.** Adaptive freeze protection functions automatically if either the 54F or 48F settings are selected for set-back. This feature checks for excessive heat loss during very cold outdoor conditions by measuring the rate at which the temperature falls during the HVAC unit's off cycle.

Excessive heat loss triggers the CS2000A to temporarily select the next higher setback temperature (up to 58F). This feature protects piping from freezing in excessively cold weather. The set-back control automatically returns to the selected value when the rate of fall returns to normal.

**Temperature Clamp.** The CS2000A employs temperature-limiting logic that prevents wasteful energy use and misoperation of the HVAC equipment. This waste occurs when personnel set the room thermostat too hot in winter or too cold in summer. The temperature clamp feature operates only when the area is occupied and the room temperature exceeds 79F in winter or falls below 67F in summer. Under normal circumstances the limit action never engages. Temperature clamp is automatic and not switch selectable. CS2000A's software automatically determines the climatic season during unoccupied periods by measuring the room temperature fall or rise. This measurement occurs whenever the CS2000A turns off the HVAC unit. The season test determines whether the upper or lower clamp functions, and cancels the function when season determination may be uncertain which can occur during mild weather conditions. Room temperatures above 79F or below 67F enable the limit action. When the limit operates the HVAC unit operation stops, allowing the room temperature to drift freely. The CS2000A calculates the direction and magnitude of the drift and verifies the season. The temperature limit remains in effect once the proper season is confirmed.

### Function and Temperature Switches Map

| FUNCTION SWITCHES |  | TEMPERATURE SWITCHES |    |
|-------------------|--|----------------------|----|
| LEARN             |  |                      | 90 |
| PRE P             |  |                      | 84 |
| MODE              |  |                      | 81 |
| RATE              |  |                      | 78 |
| SEARCH-TIME       |  |                      | 68 |
| N/C               |  |                      | 65 |
| STAGE             |  |                      | 62 |
| AUX               |  |                      | 58 |
| DEMAND 2          |  |                      | 54 |
| DEMAND 1          |  |                      | 48 |

Shaded Positions Are Factory Defaults

### Learning Schedule

The CS2000A has an enhanced learning program that works as follows:

1. There is no time clock to set or day of the week to adjust as the CS2000A learns by observation of actual events, and an internal timer keeps track of time on a 24-hour basis.
2. Learning starts to occur after initial installation and checkout, and after there has been a minimum of 7 hours unoccupied period registered.
3. The next morning arrival time is recorded as Day 1, and the following 6 days are established to have the same arrival time as Day 1. This is called "morning synchronization".
4. Day 2 will start to precondition based upon the amount of time it took for Day 1 to recover from the set-back or set-up condition the CS2000A has been configured for, and then will begin to adjust automatically if actual recovery times start to change.
5. Days 3 to 7 will follow the same strategy as Day 2.
6. Whenever the unoccupied days of the weekend occur during the first week of operation, there will be recovery in anticipation of arrival. When no one arrives within 30 minutes of the anticipated schedule the CS2000A will shift to unoccupied status and wait until the next day.
7. Days 8 to 14 fine-tune the occupancy pattern by averaging Day 1 to Day 8, Day 2 to Day 9, etc.
8. For the unoccupied weekend days after 2 weeks of no one arriving, the CS2000A logic will determine those are the weekend days and will stay in set-back or set-up condition throughout the entire period.
9. Sensing the room being occupied and enabling the room thermostat to take command and condition the room accordingly accommodate irregular or unplanned events such as a parent-teacher conference in the evening or other special meetings, or an occasional weekend work session by the teacher. 30 minutes after departure the CS2000A places the HVAC system back into the unoccupied mode.
10. Should an evening or weekend event turn into a regularly scheduled time slot that occurs within a 30-minute start window, after the 2-week learning period the CS2000A will assume it to become part of the regular schedule and put into the operating routine. If any of those usage patterns then change and no one arrives, the CS2000A will go to unoccupied status after 30 minutes of the learned arrival pattern, and after 2 weeks of seeing the same pattern will eliminate from the schedule.
11. Holidays, weather delays, and other activities such as field trips that cause the classroom to be empty will cause the CS2000A to switch to unoccupied status 30 minutes after scheduled first arrival for that day. Should classroom become occupied later on the CS2000A restores authority to the wall thermostat for occupied control.

12. When extended periods of non-activity occur such as long holiday breaks or summer recess, the CS2000A uses the logic as explained above to place the HVAC systems in continuous set-back/set-up mode, and then responds and quickly relearns the usage pattern as it happens.

### Testing and Operating Hints

1. Red LED indicator gives helpful status information:
  - a. Lights momentarily after motion detection (sample rate is every 3 seconds)
  - b. Improper temperature switch settings - continuous "slow flash"
  - c. Manual override - "fast flashes"
  - d. Incorrect switch 3 (mode) setting - continuous "On"
  - e. Out-of-range temperature - continuous "On"
2. Check placement of controller by walking around in the classroom to determine occupancy indicator (red LED) lights up in the majority of the classroom.
3. Reposition if necessary. CS2000A has 24-degree parabolic view from centerline (can sense a 3-foot tall person @ 7 feet away from CS2000A when positioned 7 feet above the floor. See pages 11 & 12.
4. A 1-hour set-up/set-back operation for testing is allowed after power-up. Normal operation begins only after morning synchronization.
5. CS2000A has power backup circuit that will retain learned program for 30 minutes during power loss. After 30 minutes, controller must relearn schedule.
6. Manual override has 24-hour operation before automatic reset.

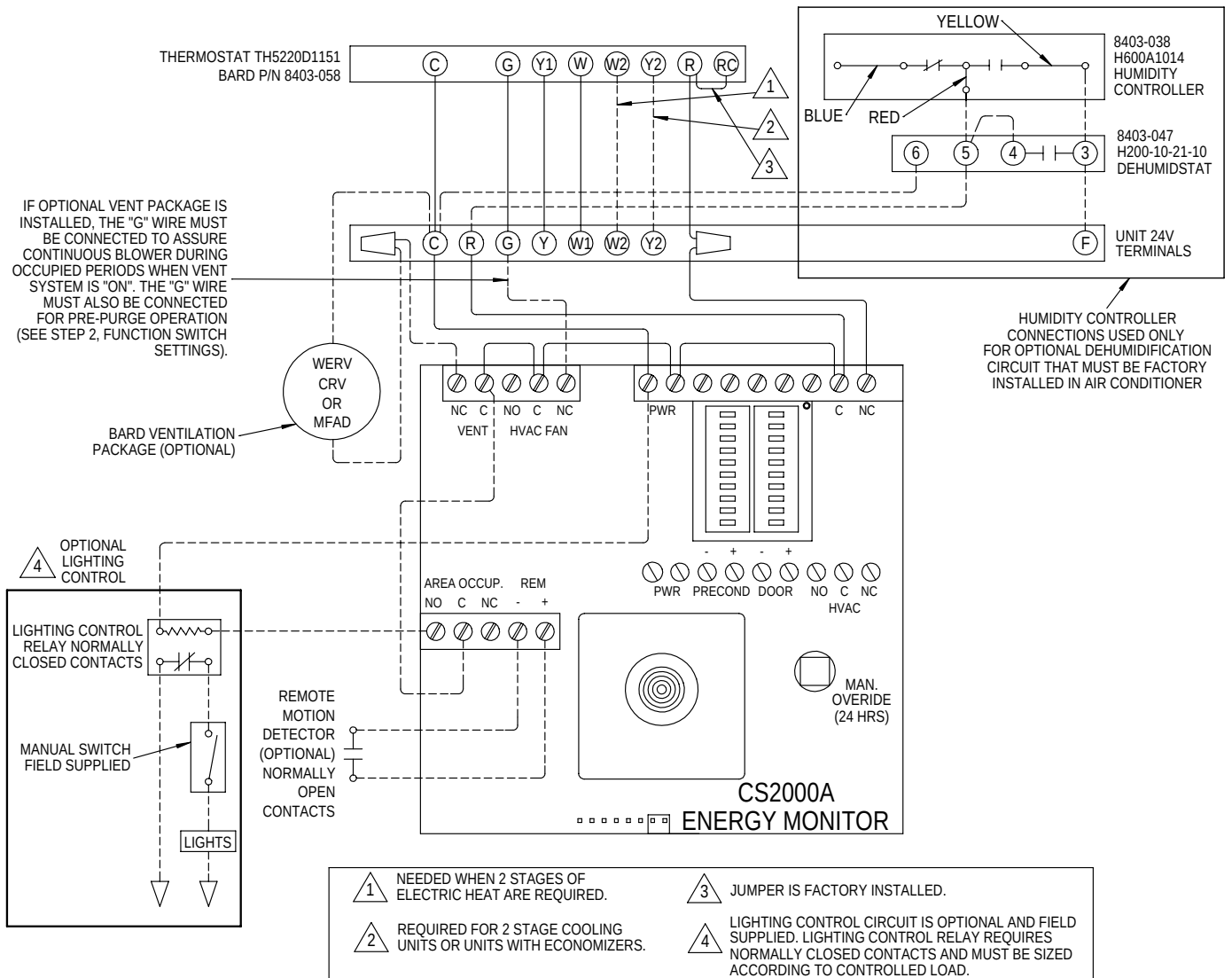
Lockout timer circuit inhibits HVAC operation for 3 minutes if 24V power to CS2000A is interrupted (requires 3 minutes for HVAC output to be switched after power up).

### Troubleshooting Hints

1. Night set-back/set-up may not engage during mild weather.
2. CS2000A and wall thermostat must be installed in the space that is being controlled.
3. Temperature clamp may infrequently inhibit operation while performing season check.
4. CS2000A's motion sensor "field of view" must cover the key occupancy/traffic pattern.
5. Inverted CS2000A case cover blocks motion sensor view. Note: this is sometimes inverted intentionally for test purposes ---- be sure not to damage or mis-align the LED.

**Unlimited/Limited Mode:** Limited mode requiring door switches is not typically used in classroom applications due to frequent door actions and in some cases doors not being closed. If used, requires all door switches to be closed and motion detected for the CS2000A to be operational.

# **WIRING DIAGRAM 1** **AIR CONDITIONER CONNECTION**

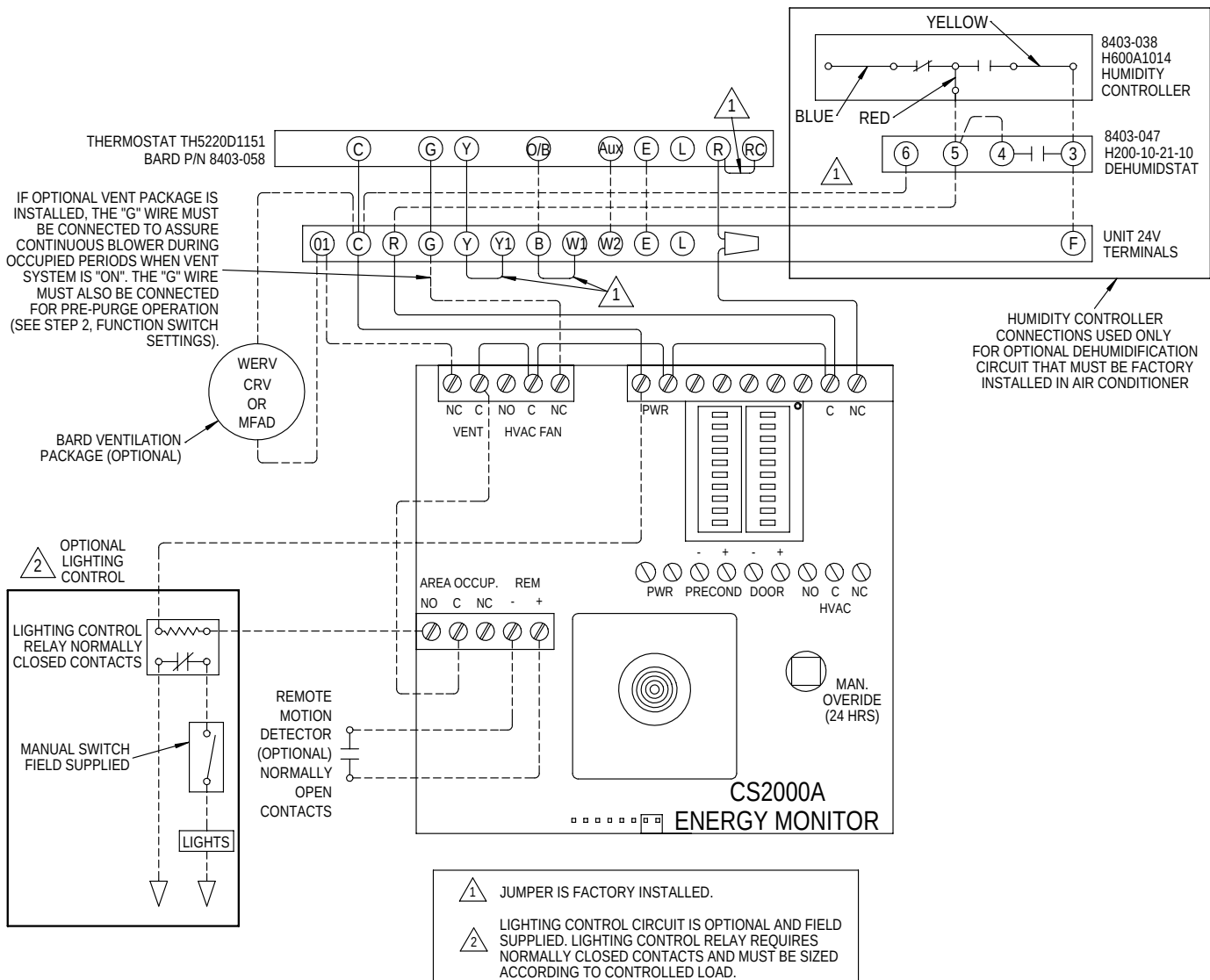


## *RECOMMENDED SWITCH SETTINGS SHOWN BELOW*

| FUNCTION SWITCHES |  | TEMPERATURE SWITCHES |    |
|-------------------|--|----------------------|----|
| LEARN             |  |                      | 90 |
| PRE P             |  |                      | 84 |
| MODE              |  |                      | 81 |
| RATE              |  |                      | 78 |
| SEARCH-TIME       |  |                      | 68 |
| N/C               |  |                      | 65 |
| STAGE             |  |                      | 62 |
| AUX               |  |                      | 58 |
| DEMAND 2          |  |                      | 54 |
| DEMAND 1          |  |                      | 48 |

4093-139 F

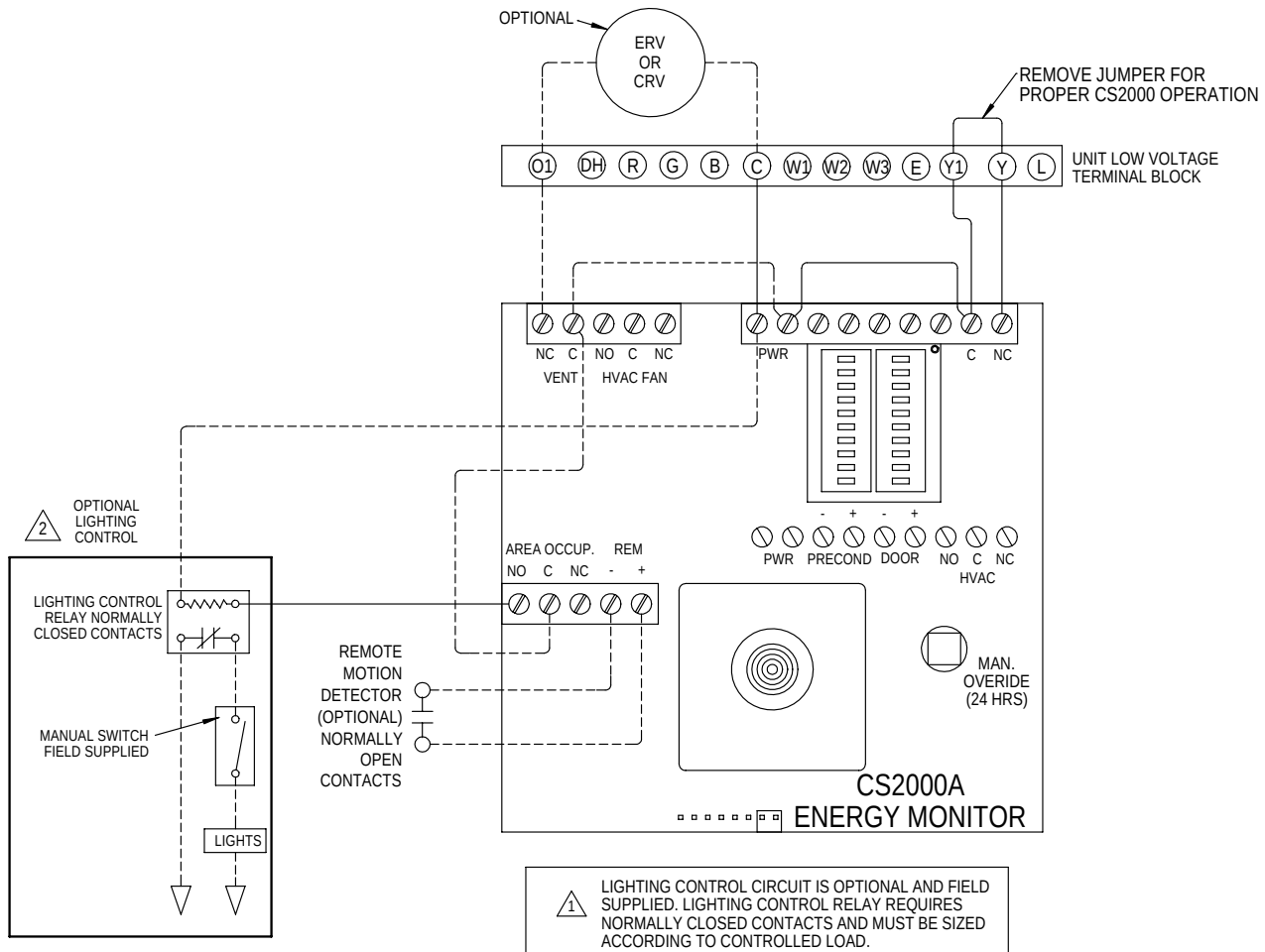
## WIRING DIAGRAM 2 HEAT PUMP CONNECTION



### RECOMMENDED SWITCH SETTINGS SHOWN BELOW

| FUNCTION SWITCHES |  | TEMPERATURE SWITCHES |    |
|-------------------|--|----------------------|----|
| LEARN             |  |                      | 90 |
| PRE P             |  |                      | 84 |
| MODE              |  |                      | 81 |
| RATE              |  |                      | 78 |
| SEARCH-TIME       |  |                      | 68 |
| N/C               |  |                      | 65 |
| STAGE             |  |                      | 62 |
| AUX               |  |                      | 58 |
| DEMAND 2          |  |                      | 54 |
| DEMAND 1          |  |                      | 48 |

**WIRING DIAGRAM 3**  
**QA, QH, QW SERIES CONNECTION**  
**FOR USE WITH "A" OR "G" CLIMATE CONTROL OPTION**

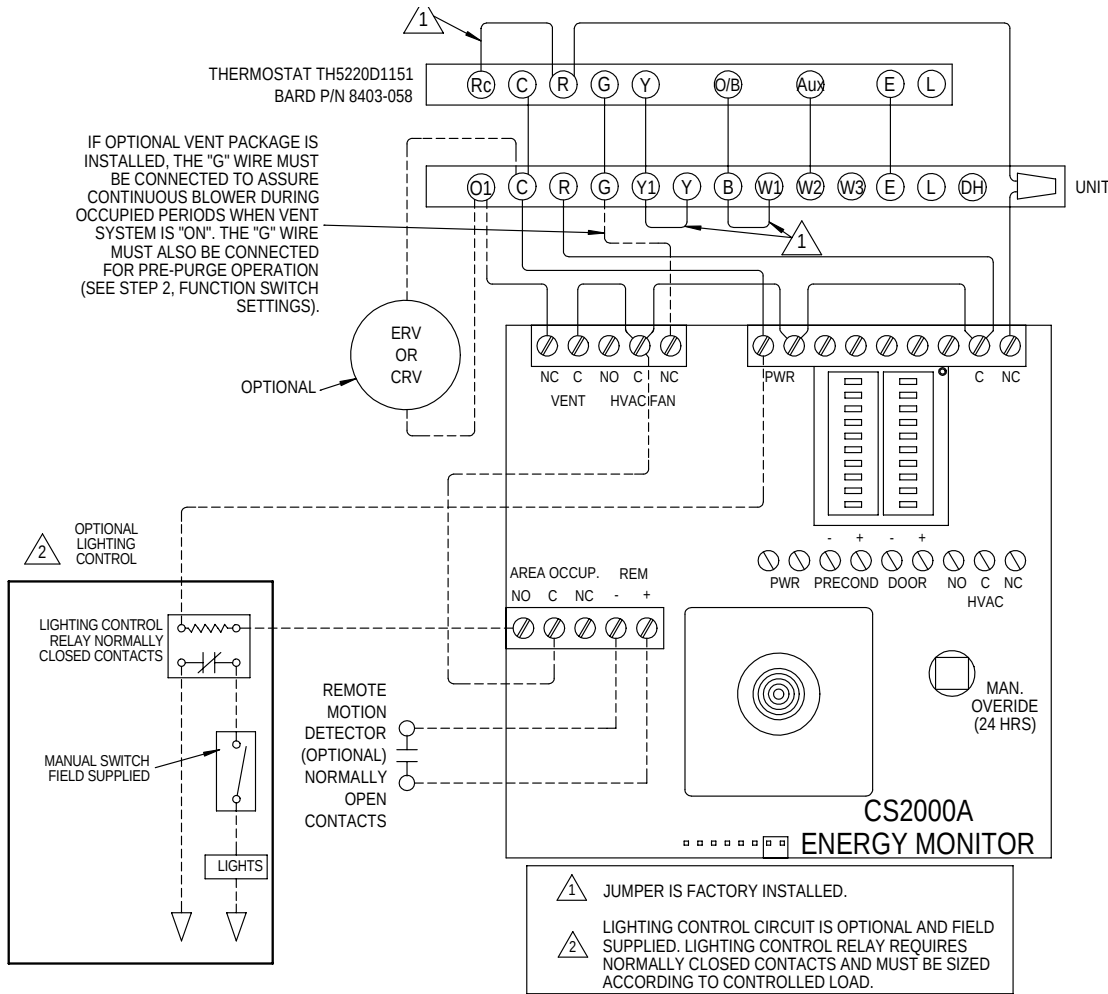


**RECOMMENDED SWITCH SETTINGS SHOWN BELOW**

| FUNCTION SWITCHES |  | TEMPERATURE SWITCHES |    |
|-------------------|--|----------------------|----|
| LEARN             |  |                      | 90 |
| PRE P             |  |                      | 84 |
| MODE              |  |                      | 81 |
| RATE              |  |                      | 78 |
| SEARCH-TIME       |  |                      | 68 |
| N/C               |  |                      | 65 |
| STAGE             |  |                      | 62 |
| AUX               |  |                      | 58 |
| DEMAND 2          |  |                      | 54 |
| DEMAND 1          |  |                      | 48 |

4093-141 F

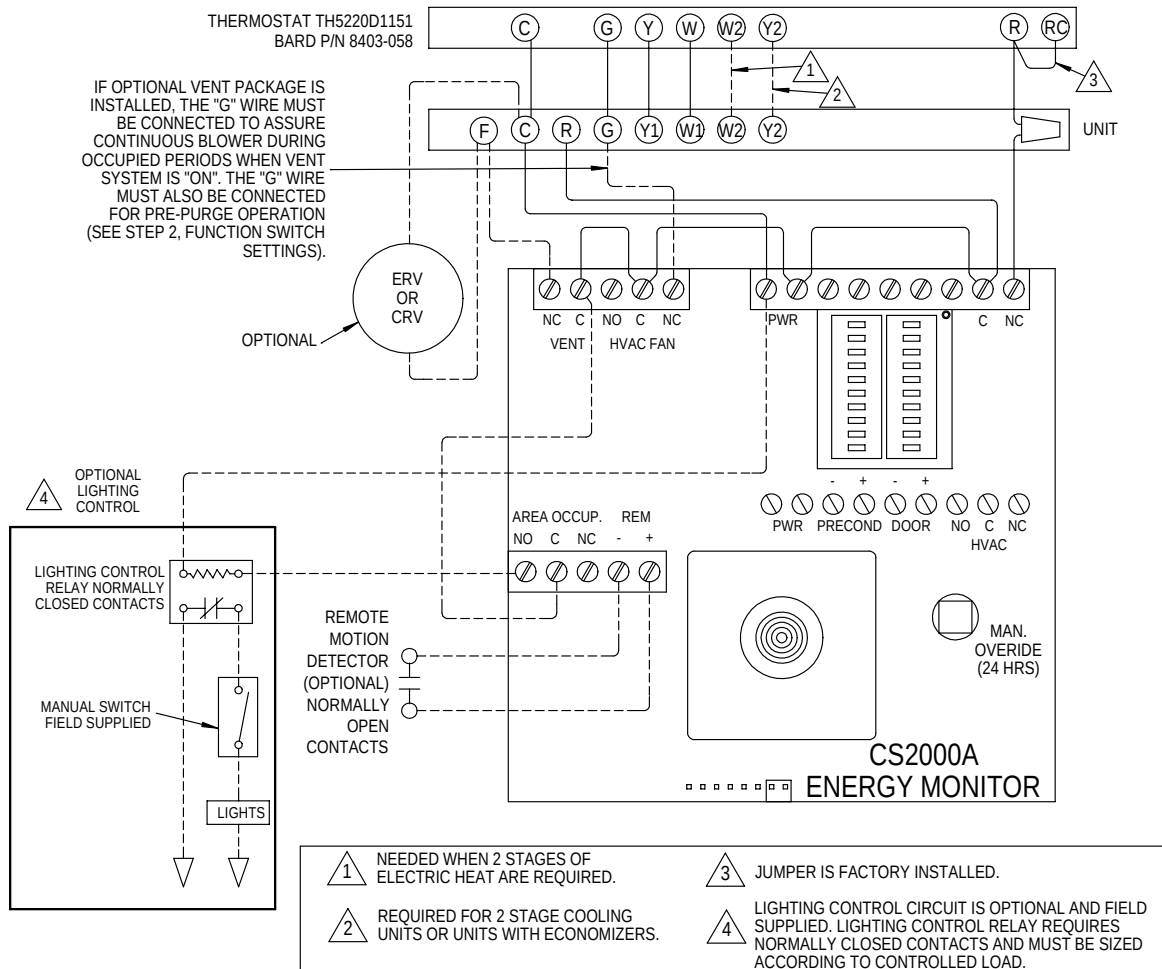
# **WIRING DIAGRAM 4** **QH, QW SERIES HEAT PUMP CONNECTION** **FOR USE WITH "X" CLIMATE CONTROL OPTION**



## *RECOMMENDED SWITCH SETTINGS SHOWN BELOW*

| FUNCTION SWITCHES |  | TEMPERATURE SWITCHES |    |
|-------------------|--|----------------------|----|
| LEARN             |  |                      | 90 |
| PRE P             |  |                      | 84 |
| MODE              |  |                      | 81 |
| RATE              |  |                      | 78 |
| SEARCH-TIME       |  |                      | 68 |
| N/C               |  |                      | 65 |
| STAGE             |  |                      | 62 |
| AUX               |  |                      | 58 |
| DEMAND 2          |  |                      | 54 |
| DEMAND 1          |  |                      | 48 |

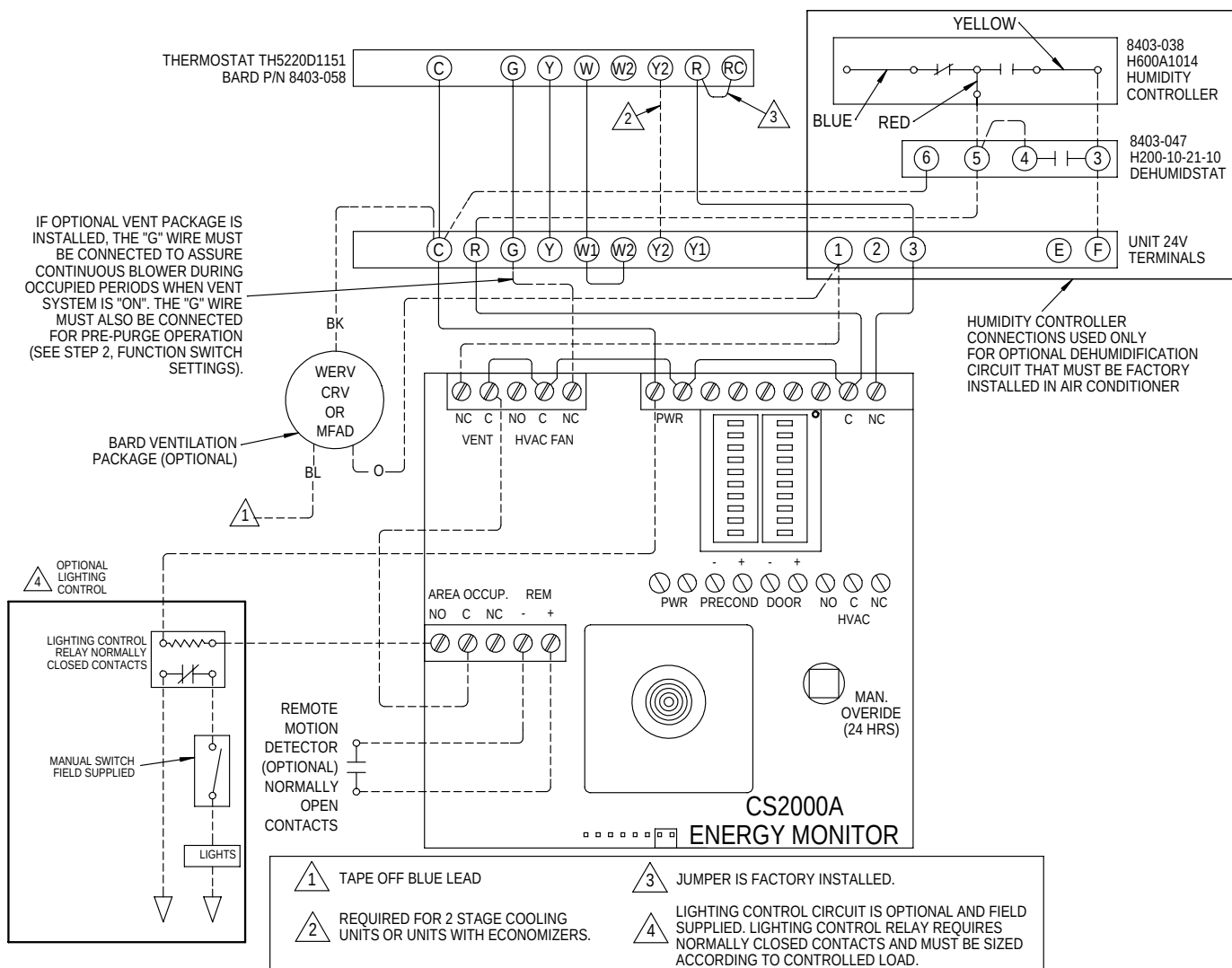
# **WIRING DIAGRAM 5** **QA SERIES AIR CONDITIONER CONNECTION** **FOR USE WITH "X" CLIMATE CONTROL OPTION**



## **RECOMMENDED SWITCH SETTINGS SHOWN BELOW**

| FUNCTION SWITCHES |  | TEMPERATURE SWITCHES |    |
|-------------------|--|----------------------|----|
| LEARN             |  |                      | 90 |
| PRE P             |  |                      | 84 |
| MODE              |  |                      | 81 |
| RATE              |  |                      | 78 |
| SEARCH-TIME       |  |                      | 68 |
| N/C               |  |                      | 65 |
| STAGE             |  |                      | 62 |
| AUX               |  |                      | 58 |
| DEMAND 2          |  |                      | 54 |
| DEMAND 1          |  |                      | 48 |

# **WIRING DIAGRAM 7** **WG SERIES GAS ELECTRIC CONNECTION DIAGRAM**



## ***RECOMMENDED SWITCH SETTINGS SHOWN BELOW***

| FUNCTION SWITCHES |  | TEMPERATURE SWITCHES |    |
|-------------------|--|----------------------|----|
| LEARN             |  |                      | 90 |
| PRE P             |  |                      | 84 |
| MODE              |  |                      | 81 |
| RATE              |  |                      | 78 |
| SEARCH-TIME       |  |                      | 68 |
| N/C               |  |                      | 65 |
| STAGE             |  |                      | 62 |
| AUX               |  |                      | 58 |
| DEMAND 2          |  |                      | 54 |
| DEMAND 1          |  |                      | 48 |

# COVERAGE AREAS OF CS2000A

Top View

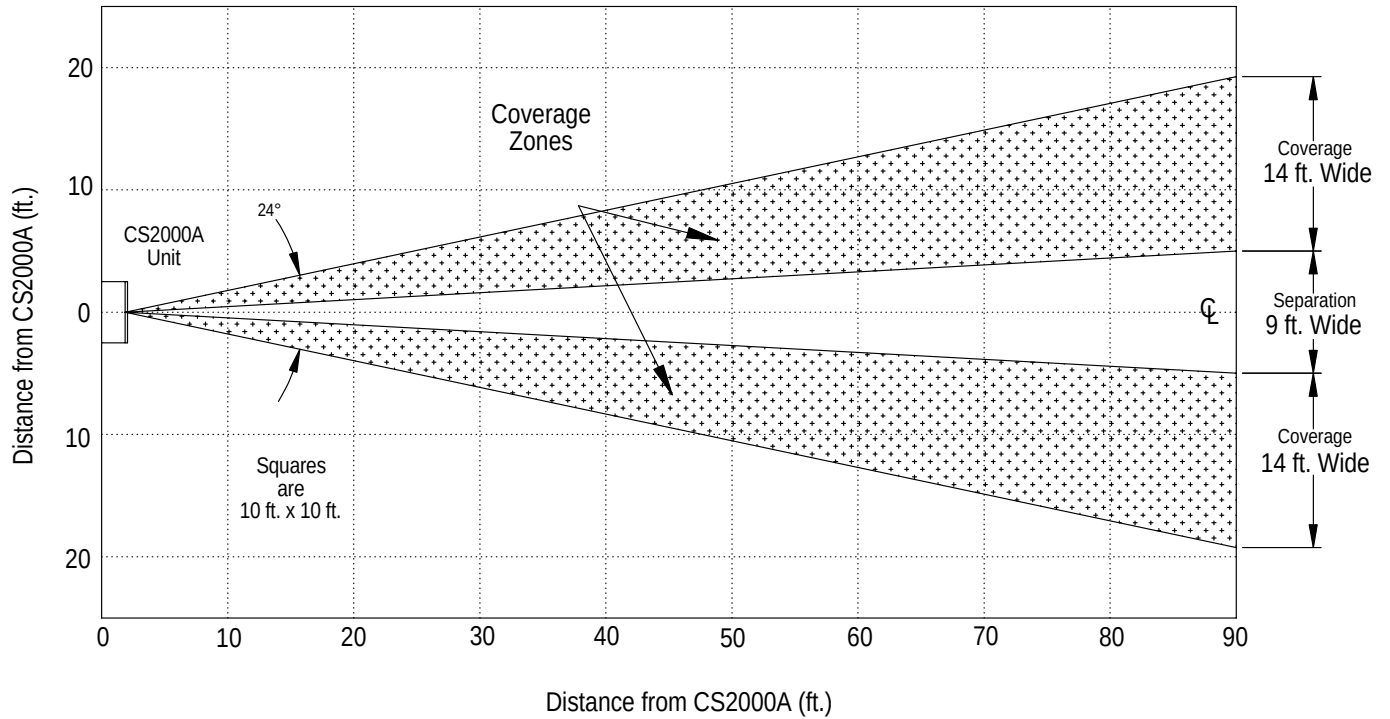


Fig. 1 Top View of CS2000A Passive Infrared Coverage ①

Side View

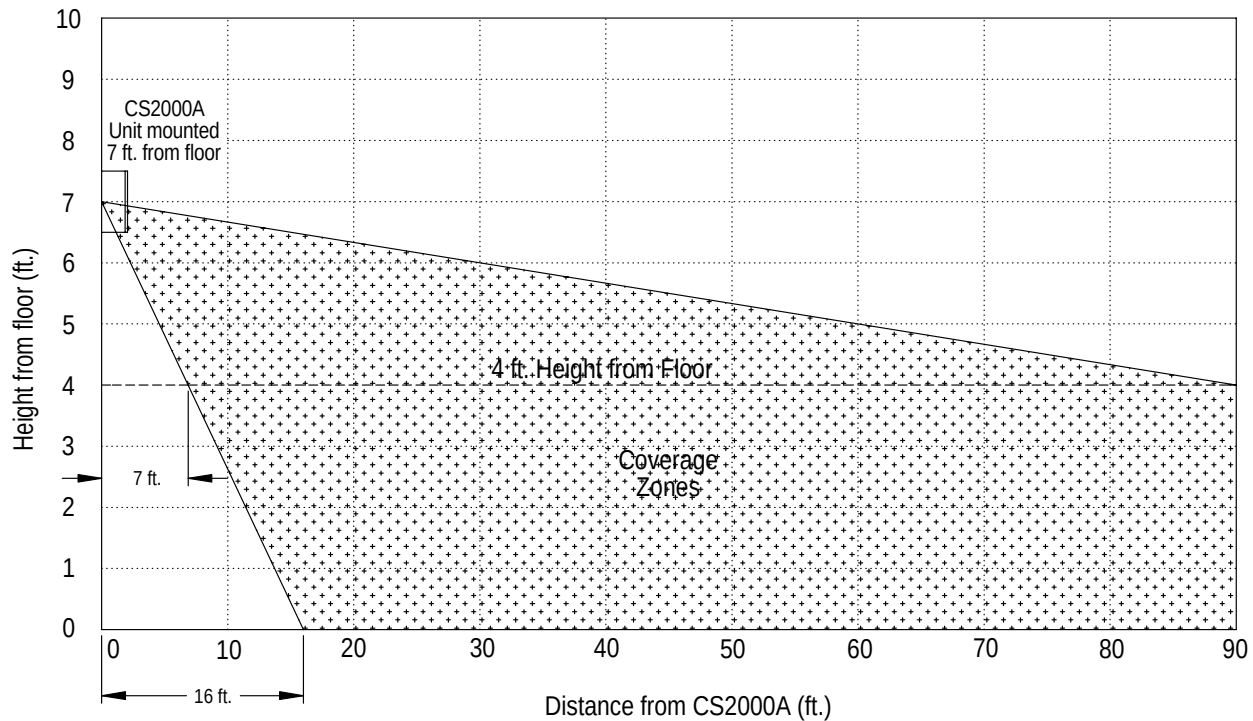


Fig. 2 Side View of CS2000A Passive Infrared Coverage ①

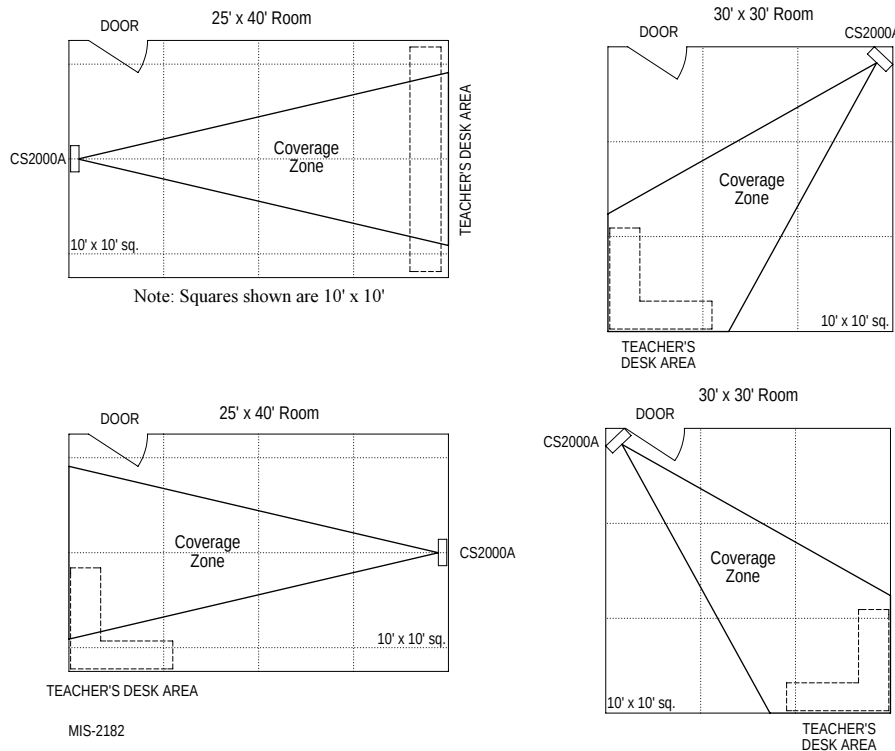
MIS-2181

① Ranges are approximate and assume that wall is plumb and floor is level.

## RECOMMENDED TYPICAL CLASSROOM APPLICATIONS and SEQUENCE OF OPERATION

A typical classroom may be 30 x 30 feet, 25 x 40 feet, or other similar sizes. If the CS2000A is also to be used for lighting control, the location of the entry door from the hallway also needs to be considered when selecting the location of the CS2000A controller.

The controller occupancy sensor does not cover 100% of the area of the room, see Coverage Areas on page 11. However, it will provide coverage for the central core (working) area of the room where one or more students are generally located. The teacher's desk may be located in one of the corners of the room and may not always be in the same location from room to room and/or may change from year to year depending upon teachers desire or a different teacher may be in that room on different years. Therefore, it is important for the CS2000A controller to be placed in the location best suited for the variables of the room, and that the teachers and maintenance staff understand the capabilities of the controller system. Shown below are some general recommendations.



The CS2000A is typically set to allow 30 minutes of HVAC control and also 30 minutes of lighting control, if so connected, after each sensed occupancy in the coverage area. Some user's may elect to set the CS2000A controller for 15 minutes of control, which means occupancy must be sensed at least once every 15 minutes. In either case, every sensed occupancy resets the controller internal timer for an additional 30 (or 15) minutes. Sensing is confirmed by the small Red lamp on the face of the controller blinking momentarily. The controller samples every 2.5 seconds, and if occupancy is sensed as the controller samples the Red lamp illuminates and the internal timer is reset.

The CS2000A controller learns the day-by-day schedules, and then anticipates first arrival and places HVAC system in operation in advance so that the space temperature is at or near the occupied settings of the room thermostat when the teacher arrives. If no one arrives within 30 minutes (or 15 if so set) of the learned arrival time for that day, the CS2000A controller will revert to unoccupied mode and wait until the next learned arrival time (the next regularly scheduled day). If there has been a school delay and persons arrive sometime later that day, the CS2000A will activate upon entry into the classroom and reestablish control (activate the room thermostat) for occupied operation. During unoccupied periods, the CS2000A becomes the control device with internal settings for set-back and set-up, depending upon the season.

When lighting control is employed, it operates differently than the HVAC control does. The lights do not come on until occupancy in the space is observed, and depending upon where the controller is located, the coverage pattern may not include the doorway and it may take several paces into the room from the doorway to be picked up by the occupancy sensor in the CS2000A. This is typically not an issue as one is generally entering from a lighted hallway. The lights should come on as soon as occupancy is sensed, which is also when the small Red lamp on the face of the controller lights up. To avoid false activation of the lighting control circuit, the controller requires a total of 3 sensed occupancy readings initially, and these can occur in as short a time as 5-6 seconds after the initial sensing that turns off the room lights. If all 3 occupancy readings are not registered, the lighting could shut off in approximately 25 seconds or possibly in an additional 25 seconds (a second occupancy reading but not the third during the first 25 seconds will reset a timer for an additional 25 seconds, during which time the third sensing must occur or lights will turn off). Typically this is not an issue, but it can be depending upon doorway location, placement of the CS2000A controller, location of teachers desk, and teacher habits or pattern of entry. If lights cycle off very quickly after initial entry, simply have the teacher walk through the central area of the classroom and dwell for 5-10 seconds to become registered 3 times as indicated by the Red lamp blinking. A similar issue can occur at the end of the class day when the students occupying the central area of the room leave, and the teachers desk is located where it is "out of view" by the occupancy sensor. 30 minutes after the last student leaves, the lights might cycle off as the teacher works at their desk. Again, once an understanding is reached, they will know what is happening and if they are staying longer they will need to walk through the central area to reactivate the controller, which will again take 3 registrations (Red light blinks) to lock in the 30 minutes. If the teacher walks through the central sensing area anytime within 30 minutes following the students leaving (which may be normal occurrence anyway) the lights should stay on with no problem.