# CB780/CB784 Relay Modules

**INSTALLATION INSTRUCTIONS**


## APPLICATION

The Cleaver-Brooks CB780/CB784 (833-2718/833-2720) is a microprocessor based integrated burner control for automatically fired gas, oil, or combination fuel single burner applications. The CB780 consists of a Relay Module and Keyboard Display Module. The CB784 consists of the Relay Module only. The Keyboard Display Module is optional with the CB784. Subbase, Amplifier, and Purge Card are required to complete the system. Options include DATA CONTROLBUS MODULE™*, Remote Display Mounting, First-Out Expanded Annunciator or Modbus™ Module.

The CB780/CB784 is programmed to provide a level of safety, functional capability and features beyond the capacity of conventional controls.

Functions provided by the CB780/CB784 include automatic burner sequencing, flame supervision, system status indication, system or self-diagnostics and troubleshooting

## FEATURES

- **Safety features:**
  - **Interlock check.**
  - **Closed loop logic test.**
  - **Dynamic AMPLI-CHECK™.**
  - **Dynamic input check.**
  - **Dynamic safety relay test.**
  - **Dynamic self-check logic.**
  - **Expanded safe-start check.**
  - **High Fire Purge Switch test.**
  - **Internal hardware status monitoring.**
  - **Low Fire Start Switch test.**
  - **Tamper resistant timing and logic.**
- **Access for external electrical voltage checks.**
- **Application flexibility.**
- **Communication interface using Modbus Module 833-2820.**
- **Dependable, long-term operation provided by microcomputer technology.**
- **First-out annunciation and system diagnostics provided by a 2 row by 20 column Vacuum Fluorescent Display (VFD) located on the Keyboard Display Module (Optional on CB784).**

**Contents**



SIL3 Capable

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- **First-out expanded annunciation with 26 Light Emitting Diodes (LEDs) for limits and interlocks (optional).**
- **Five sequence information Light Emitting Diodes (LEDs).**
- **Five function Run/Test Switch.**
- **Interchangeable plug-in flame amplifiers.**
- **Local or remote annunciation of operation and fault information.**
- **Nonvolatile memory for retaining history files and sequencing status after loss of power.**
- **Remote reset (optional).**
- **Report generation (optional).**
- **Burner controller data:**
  - **— Sequence status.**
  - **— Sequence time.**
  - **— Hold status.**
  - **— Lockout/alarm status.**
  - **— Flame signal strength.**
  - **— Expanded annunciator status.**
  - **— Total cycles of operation.**
  - **— Total hours of operation.**
  - **— Fault history of six most recent faults:**
    - Cycles of operation at time of fault.
    - Expanded annunciator data at time of fault.
    - Fault message and code.
    - **Hours of operation at time of fault.**
      - Sequence status at time of fault.
      - Sequence time at time of fault.
  - **— Diagnostic information:**
    - Device type.
    - Flame amplifier type.
    - Flame failure response time.
    - Manufacturing code.
    - On/Off status of all digital inputs and outputs.
    - Selected prepurge time.
    - Software revision and version of CB780/CB784 and Keyboard Display Module.
    - Status of configuration jumpers.
    - Status of Run/Test Switch.

# SPECIFICATIONS

**Electrical Ratings (see Table 1):**
Voltage and Frequency: 120 Vac (+10/-15%), 50 or 60 Hz (±10%).
Keyboard Display Module: 13 Vdc peak full wave rectified (+20/-15%).
Power Dissipation:
CB780/CB784: 10W maximum.
Display Module: 3W maximum.
Maximum Total Connected Load: 2000 VA.
Fusing: 15A maximum, Type SC or equivalent—fast blow.

**Table 1. Terminal Ratings.**

| Terminal No. | Description | Ratings |
|---|---|---|
| G | Flame Sensor Ground[a] | — |
| Earth G | Earth Ground[a] | — |
| L2(N) | Line Voltage Common | — |
| 3 | Alarm | 120 Vac, 1A pilot duty. |
| 4 | Line Voltage Supply (L1) | 120 Vac (+10%/-15%), 50 or 60 Hz (±10%).[b] |
| 5 | Burner Motor | 120 Vac, 9.8AFL, 58.ALR (inrush). |
| 6 | Burner Controller and Limits | 120 Vac, 1 mA. |
| 7 | Lockout/Running Interlock | 120 Vac, 8A. |
| 8 | Pilot Valve/Ignition | 120 Vac, 4.5A ignition and 50VA pilot duty.[c] |
| 9 | Main Fuel Valve | 120 Vac, 2A pilot duty.[d] |
| 10 | Ignition | 120 Vac, 4.5A ignition.[c] |
| F(11) | Flame Sensor | 60 to 220 Vac, current limited. |
| 12 | Firing Rate High Fire | 120 Vac, 75VA pilot duty. |
| 13 | Firing Rate Common | 120 Vac, 75VA pilot duty. |
| 14 | Firing Rate Low Fire | 120 Vac, 75VA pilot duty. |
| 15 | Firing Rate Modulate | 120 Vac, 75VA pilot duty. |
| 16 | Unused | — |
| 17 | Unused | — |
| 18 | Low Fire Switch Input | 120 Vac, 1 mA. |
| 19 | High Fire Switch Input | 120 Vac, 1 mA. |
| 20 | Preignition Interlock Input | 120 Vac, 1 mA. |
| 21 | Interrupted/Pilot Valve/First Stage Oil Valve | 120 Vac, 2A pilot duty. |
| 22 | Shutter | 120 Vac, 0.5A. |

[a] The CB780/CB784 *must have* an earth ground providing a connection between the subbase and the control panel or the equipment. The earth ground wire must be capable of conducting the current to blow the 15A fuse (or breaker) in event of an internal short circuit. The CB780/CB784 needs a low impedance ground connection to the equipment frame which, in turn, needs a low impedance connection to earth ground. For a ground path to be low impedance at RF frequencies, the connection must be made by minimum length conductors having maximum surface areas. Wide straps or brackets are preferred rather than leadwires. Be careful to ensure that mechanically tightened joints along the ground path, such as pipe or conduit threads or surfaces held together with fasteners, are free of nonconductive coatings and are protected against mating surface corrosion.

[b] 2000 VA maximum connected load to CB780/CB784 Assembly.

[c] Can also be 120 Vac, 1A pilot duty, Terminals 8 & 10 sum of the “c“ loads must not exceed 8A.

[d] Can also be 65 VA pilot duty with motorized valve, 1150 VA inrush, 460 VA open, 250 VA hold.

**Environmental Ratings:**
Ambient Temperature:
Operating: -40°F to +140°F (-40°C to +40°C).
Storage: -40°F to +150°F (-40°C to +66°C).
Humidity: 85% RH continuous, noncondensing.
Vibration: 0.5G environment.

**Dimensions:**
Refer to Fig. 1 and 2.

**Weight:**
CB780/CB784: 1 pound 10 ounces, unpacked.
Keyboard Display Module: 4 ounces, unpacked.

**IMPORTANT:**
*Flame Detection System available for use with CB780/CB784. To select your Plug-in Flame Signal Amplifier and matching Flame Detector, see Table 2.*

**Table 2. Flame Detection Systems (Fig. 3, 4, 5).**

| Plug-In Flame Amplifiers | | | | Applicable Flame Detectors | | | |
|---|---|---|---|---|---|---|---|
| **Type** | **Color** | **Self-Checking** | **Part Number** | **Flame Failure Response Time** | **Fuel** | **Type** | **Part Number** |
| Infrared | Red | No | 833-2722 | 3 sec. | Gas, oil, coal | Infrared (Lead Sulfide) | 817-1742 |
| | | Dynamic AMPLI-CHECK™ | 833-2723[a] | | | | |
| | Red/White | No | 833-3495 | | | Infrared | 817-4133 |
| | | Dynamic AMPLI-CHECK™ | 833-3496[a] | | | | |
| Ultraviolet | Purple | No | 833-2724 | | Gas, oil | Ultraviolet | 817-1743[b] |
| Ultraviolet Self-Check | Green | Dynamic Self-Check | 833-2741[c] | | Gas, oil, coal | Ultraviolet (Purple Peeper®) | 817-1121 |

[a] Circuitry tests the flame signal amplifier 12 times a minute during burner operation and shuts down the burner if the amplifier fails.

[b] The 817-1743 Flame Detector should be used only on burners that cycle on-off at least once every twenty-four hours. Appliances with burners that remain on for twenty-four hours continuously or longer should use the 817-1121 Flame Detector with the 833-2741 Amplifier as the ultraviolet flame detection system.

[c] Circuitry tests all electronic components in the flame detection system (amplifier and detector) 12 times a minute during burner operation and shuts down the burner if the detection system fails. Series 4 amplifiers check 60 to 120 times per minute.

**Table 3. Sequence Timing For Normal Operation.[a]**

| Device | Initiate | Standby | Purge | Flame Establishing Period | | Run | Post Purge Timing | Interlock Circuits | Firing Rate Circuit | Energy Saving Prepurge | Approval Code Bodies |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Pilot | Main | | | | | | |
| CB780/ CB784 | 10 sec. | * | ** | 4 or 10 sec. | 10 or 15 sec.[b] | * | 15 sec. | Preignition, Lockout, High and Low Fire | 4-wire modulating | No | FM/IRI Modulating |

*STANDBY and RUN can be an infinite time period.
**PURGE will be determined by which purge card is selected.

[a] The operating sequence of the CB780 and CB784 Relay Modules are identical. The only difference between the Relay Modules is that the Keyboard Display Module is *standard* with the CB780 and *optional* with the CB784.

[b] The MFEP will be determined by which terminal is used, see Fig. 7 and 18.

**SIL 3 Capable:**

SIL 3 Capable in a properly designed Safety Instrumented System. See form number 65-0312 for Certificate Agreement.

**Approvals:**
Underwriters Laboratories Inc. listed, File No. MP268, Guide No. MCCZ.
Factory Mutual approved, Report No. 1V9A0. AF.
IRI acceptable.
Federal Communications Commission, Part 15, Class B—Emissions.

**Mounting:**
833-2725 for panel mount.

**Required Components:**
CB780: 120 Vac, 50/60 Hz, 833-2718.
CB784: 120 Vac, 50/60 Hz, 833-2720.
Plug-in Flame Signal Amplifier, see Table 2.
Plug-in Purge Timer Cards: selectable:
833-2730—30 sec.
833-2731—60 sec.
833-2732—90 sec.
833-2733—-2-1/2 min.

NOTE: The CB780 and CB784 are identical except for the Keyboard Display Module which is standard with the CB780 and optional with the CB784.

**Accessories:**
Optional:
DATA CONTROLBUS MODULE™—part no. 833-2729. Provides communication and remote reset capabilities on CB784; remote display capabilities on CB780 and CB784.
CB783 Expanded Annunciator—part no. 833-2726.
Keyboard Display Module—part no. 833-2727. (Standard on CB780; optional on CB784.)
Remote Mounting Kit for the Keyboard Display, NEMA 4—part no. 833-2740.
Tester—part no. 626-5050.

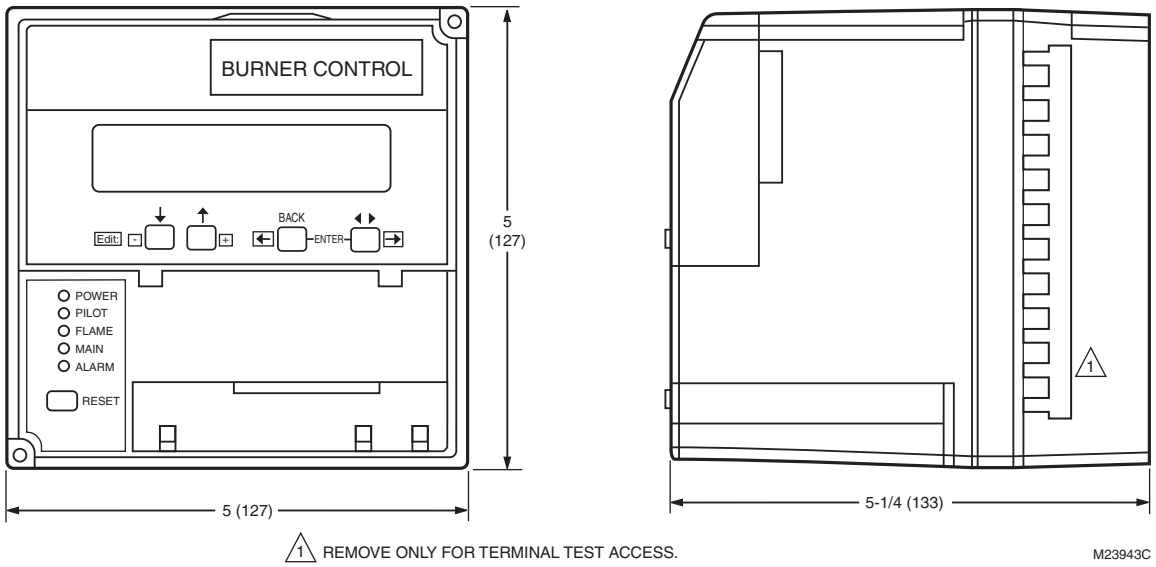



**Fig. 1. Mounting dimensions of CB780/CB784 Relay Module and 833-2725 Subbase, in inches (mm).**

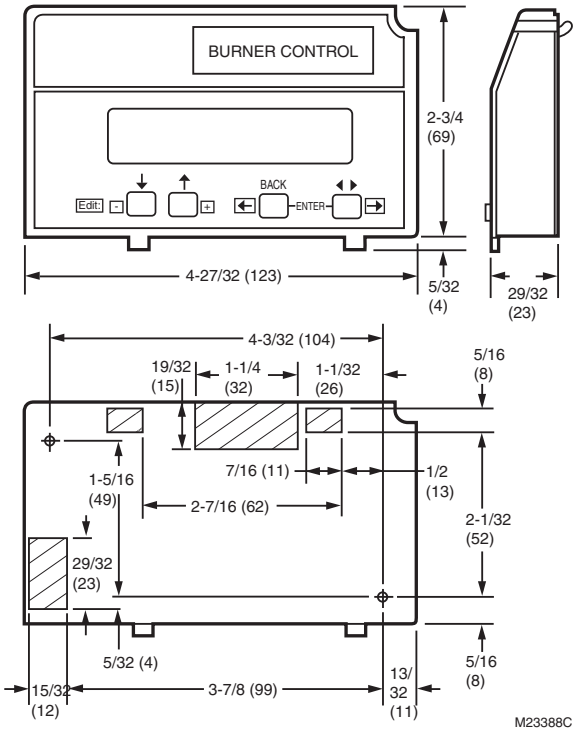



**Fig. 2. Mounting dimensions of Keyboard Display Module, in inches (mm).**

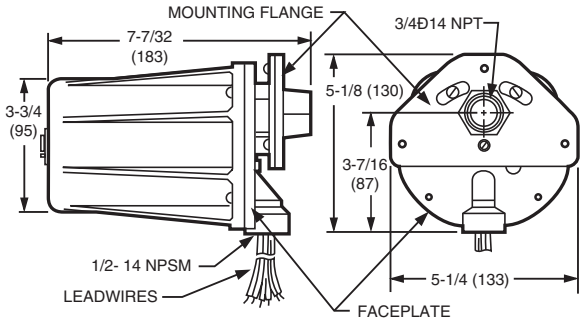



**Fig. 3. Ultraviolet Self-Check detector, mounting dimensions in inches (mm).**

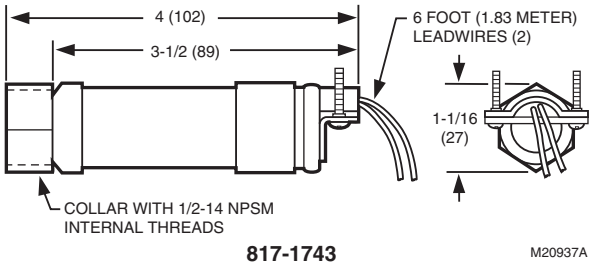



**Fig. 4. Ultraviolet detector, mounting dimensions in inches (mm).**

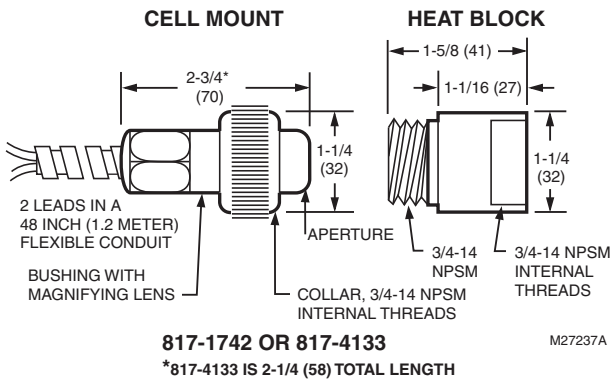



**Fig. 5. Infrared detector, mounting dimensions in inches (mm).**

# PRINCIPAL TECHNICAL FEATURES

The CB780/CB784 provides all customary flame safeguard functions while providing significant advancements in the areas of safety, annunciation and system diagnostics.

## Safety Shutdown (Lockout) Occurs If:

1. INITIATE Period
   a. Purge card is not installed or removed.
   b. Purge card is bad.
   c. Configuration jumpers were changed (after 200 hours).
   d. AC line power errors, see Operation.
   e. Four minute INITIATE period is exceeded.
2. STANDBY Period
   a. Flame signal is present after 240 seconds.
   b. Preignition Interlock is open an accumulative time of 30 seconds.
   c. Interlock check feature is enabled and the Interlock String (including the airflow switch) is closed for 120 seconds with controller closed.
   d. Ignition/pilot valve/intermittent pilot valve terminal is energized.
   e. Main valve terminal is energized.
   f. Internal system fault.
   g. Purge card is not installed or removed.
   h. Purge card is bad.
3. PREPURGE Period
   a. Preignition Interlock opens anytime during PREPURGE.
   b. Flame signal detected after first ten seconds during PREPURGE.
   c. High Fire Switch fails to close within four minutes, fifteen seconds after firing rate motor is commanded to drive to high fire position at start of PREPURGE.
   d. Low Fire Switch fails to close within four minutes, fifteen seconds after firing rate motor is commanded to drive to low fire position at end of PREPURGE.
   e. Lockout Interlock does not close within 10 seconds.
   f. Lockout Interlock opens during PREPURGE.
   g. Ignition/pilot valve/intermittent pilot valve terminal is energized.
   h. Main valve terminal is energized.
   i. Internal system fault.
   j. Purge card is removed.
   k. Purge card is bad.
4. PILOT FLAME ESTABLISHING Period (PFEP)
   a. Low Fire Switch opens.
   b. Lockout Interlock opens.
   c. Ignition/pilot valve/intermittent pilot valve terminal is not energized.
   d. Early Spark Termination terminal is energized after five seconds.
   e. No flame is present at end of PFEP.
   f. Internal system fault.
   g. Purge card is removed.
   h. Purge card is bad.
5. MAIN FLAME ESTABLISHING Period (MFEP)
   a. Low Fire Switch opens.
   b. Lockout Interlock opens.
   c. Ignition/pilot valve/intermittent pilot valve terminal is not energized.
   d. Main valve terminal is not energized.
   e. No flame is present at end of MFEP.
   f. Internal system fault.
   g. Purge card is not installed or removed.
   h. Purge card is bad.
6. RUN Period
   a. No flame is present.
   b. Lockout Interlock opens.
   c. Main valve terminal is not energized.
   d. Internal system fault.
   e. Purge card is not installed or removed.
   f. Purge card is bad.
7. POSTPURGE Period
   a. Preignition Interlock does not close within five seconds or opens after five-second time period.
   b. Ignition/pilot valve/intermittent pilot valve terminal is energized.
   c. Main valve terminal is energized.
   d. Internal system fault.
   e. Purge card is removed.
   f. Purge card is bad.

# SAFETY PROVISIONS

## Internal Hardware Status Monitoring

The CB780/CB784 checks the purge card for correct parity to prevent purge timing shifts and circuitry failures. It also analyzes the integrity of the configuration jumpers and internal hardware. The POWER LED blinks every four seconds, signifying an internal hardware check.

## Closed Loop Logic Test

The test verifies the integrity of all safety critical loads, terminals 8, 9, 10 and 21. If the loads are not energized properly; i.e., the main valve terminal is powered during PREPURGE, the CB780/CB784 will lockout on safety shutdown. The CB780/CB784 must react to input

changes but avoid the occurrence of *nuisance* shutdown events. Signal conditioning is applied to line voltage inputs to verify proper operation in the presence of *normal* electrical line noise such as transient high voltage spikes or short periods of line dropout. Signal conditioning is tolerant of synchronous noise (line noise events that occur at the same time during each line cycle).

## Dynamic Ampli-Check™

Dynamic AMPLI-CHECK™ circuitry tests the flame signal amplifier during burner operation and shuts down the CB780/CB784 if the flame amplifier fails.

## Dynamic Flame Amplifier and Shutter Check

Self-checking circuitry tests all electronic components in the flame detection system and amplifier 10 to 12 times per minute and shuts down the CB780/CB784 if the detection system fails.

## Dynamic Input Check

All system input circuits are examined to verify that the CB780/CB784 is capable of recognizing the true status of external controls, limits and interlocks. If any input fails this test, a safety shutdown occurs and the fault is annunciated.

## Dynamic Safety Relay Test

Checks the ability of the dynamic safety relay contacts to open and close. It also verifies that the safety critical loads, terminals 8, 9, 10 and 21, can be de-energized, as required, by the Dynamic Self-Check logic.

## Dynamic Self-Check Safety Circuit

The microcomputer tests itself and related hardware while at the same time the safety relay system tests the microcomputer operation. If a microcomputer or safety relay failure occurs and does not allow proper execution of the
self-check routine, safety shutdown will occur and all safety critical loads will be de-energized.

## Expanded Safe-Start Check

The conventional safe-start check, which prevents burner start-up if flame is indicated at start-up, is expanded to include a flame signal check during STANDBY, a preignition interlock check, an interlock check, and a safety critical load check.

## High Fire Purge and Low Fire Start Switch Tests

*High Fire Purge Switch Test* examines the Purge Position Interlock Switch at the moment the firing rate motor is commanded to the high fire position. If the switch is bypassed, welded or otherwise closed prematurely, the system will automatically add 30 seconds to allow additional drive time for the firing rate motor to reach or near the open position before starting the purge timing; otherwise, purge timing starts when the High Fire Switch is closed. This switch will also cause a hold (four minutes, fifteen seconds) condition when the switch is open before purge or opens during purge. The
CB780/CB784 will lockout and annunciate an alarm if the switch fails to close within the hold time period.

*Low Fire Start Switch Test* examines the Low Fire Start Switch at the moment PREPURGE is completed. If the switch is bypassed, welded or otherwise prematurely closed, the system automatically adds 30 seconds to allow the firing rate motor additional time to reach or near the low fire start position before ignition trials; otherwise, ignition trials start after the Low Fire Switch closes. The test also is used to prove that the firing rate motor is at low fire position throughout the ignition trial period. This switch will also cause a hold (four minutes, fifteen seconds) condition if the switch opens after purging is complete. The CB780/CB784 will lockout and annunciate an alarm if the switch fails to close within the hold time period.

## Mandatory Purge

If lockout occurs after the initiation of ignition trials, (or at anytime during a sequence when the fuel valves may have been energized), a mandatory POSTPURGE period is imposed.

## Off Cycle (STANDBY or PREPURGE) Flame Signal Check

The flame detection subsystem (flame detector and amplifier) is monitored during STANDBY. If a flame simulating condition or an actual flame exists, a system hold occurs and start-up is prevented. If the flame signal exists at any time after the first 40 seconds of STANDBY, a safety shutdown will occur and be annunciated. A shutter-check amplifier and self-checking detector are energized for the first 40 seconds during STANDBY and the last two seconds before exiting STANDBY. If a flame exists, a safety shutdown occurs. An
AMPLI-CHECK™ Amplifier is energized continually through STANDBY and PREPURGE to detect any possibility of a runaway detector or a flame. If either situation happens, a safety shutdown occurs. A standard amplifier is energized continually through STANDBY and PREPURGE. If either situation happens, a safety shutdown occurs.

## Preignition Output Circuit Check

At the end of PREPURGE, the Dynamic Safety Relay operation is checked. Also, all safety critical loads, terminals 8, 9, 10 and 21 are checked to verify the terminals are not powered. If the Dynamic Safety Relay operation is faulty, or if any of the safety critical loads are powered, safety shutdown occurs and is annunciated.

## Tamper-Resistant Timing and Logic

Safety and logic timings are inaccessible and cannot be altered or defeated.

## Verified Spark Termination

The ignition terminal is monitored to verify early spark termination (five seconds ignition and pilot and five seconds *pilot only*).

## First-Out Annunciation and Self-Diagnostics

*Sequence Status Lights* (LEDs) provide positive visual indication of the program sequence: POWER, PILOT, FLAME, MAIN and ALARM. The green POWER LED blinks every four seconds to signify the CB780/CB784 hardware is running correctly.

*Multi-function Keyboard Display Module* (standard with CB780, optional with CB784) shows elapsed time during PREPURGE, PILOT IGN, MAIN IGN, and POSTPURGE. As an additional troubleshooting aid, it provides sequence timing, diagnostic information, historical information and expanded annunciator information when a safety shutdown or hold or normal operation occurs.

*First-out Annunciation* reports the cause of a safety shutdown or identifies the cause of a failure to start or continue the burner control sequence with an English text and numbered code via the Keyboard Display Module. It monitors all field input circuits, including the Flame Signal Amplifier and Firing Rate Position Switches. The system distinguishes 118 modes of failure and detects and annunciates difficult-to-find intermittent failures.

*Self-Diagnostics* adds to the First-out Annunciation by allowing the CB780/CB784 to distinguish between field (external device) and internal (system related) problems. Faults associated within the flame detection subsystem, CB780/CB784 or plug-in Purge Card, are isolated and reported by the Keyboard Display Module, see Troubleshooting section and CB780/CB784 System Annunciation Diagnostics and Troubleshooting, Bulletin Number CB-7803.

## Interlock Requirements

The following interlock inputs are provided:

### Low Fire Interlock

This interlock verifies the firing rate motor is in the low fire position before and during ignition trials.

### High Fire Interlock

This interlock verifies the firing rate motor is in the high fire position prior to and during PREPURGE.

### Lockout Interlock

This interlock (ILK) input signifies a Lockout Interlock. If the Lockout Interlock is open for more than ten seconds into PREPURGE, the CB780/CB784 will lockout. After entering PREPURGE, if the Lockout Interlock opens during the first ten seconds, the purge timer will be reset. This provides a continuous PURGE to occur without interruption before the Pilot Flame Establishing Period. If a Lockout Interlock opens anytime after ten seconds into PURGE, during the Ignition Trials or Run, it causes a lockout.

A typical Lockout Interlock string contains an airflow switch (see Fig. 7). The Interlock Check is a site configurable option (see Table 7). If this feature is enabled, the CB780/CB784 will lockout after 120 seconds whenever control terminal 6 is energized, and the Lockout Interlock string (including airflow switch) is closed during STANDBY.

### Preignition Interlock

The Preignition Interlock input is typically connected to proof-of-closure switches for fuel valve(s). The Preignition Interlock must be energized throughout PREPURGE. If the Preignition Interlock opens during STANDBY, it causes a hold (30 seconds). The CB780/CB784 will lockout if the interlock does not close within 30 seconds during STANDBY. If the Preignition Interlock opens during PREPURGE, it will lockout. If the Preignition Interlock is open after five seconds into POSTPURGE, the CB780/CB784 will lockout. The Preignition Interlock is ignored during the ignition trials state and during RUN.

# INSTALLATION

**⚠ WARNING**

**Fire or Explosion Hazard.**
**Can cause severe injury, death or property damage.**
To prevent possible hazardous burner operation, verification of safety requirements must be performed each time a control is installed on a burner.

## When Installing This Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and marked on the product to make sure the product is suitable for the application.
3. Installer must be a trained, experienced, flame safeguard technician.
4. After installation is complete, check out the product operation as provided in these instructions.

**⚠ WARNING**

**Electrical Shock Hazard.**
**Can cause severe injury, death or property damage.**
Disconnect the power supply before beginning installation to prevent electrical shock, equipment and control damage. More than one power supply disconnect may be involved.

## Wiring Information

1. Wiring connections for the CB780/CB784 are unique; therefore, refer to Figs. 6, 7, 8 or 9 or the correct Specifications for proper subbase wiring.
2. Wiring must comply with all applicable codes, ordinances and regulations.

3. Wiring, where required, must comply with NEC Class 1 (Line Voltage) wiring.
4. Loads connected to the CB780/CB784 must not exceed those listed on the CB780/CB784 label or the Specifications, see Table 1.
5. Limits and interlocks must be rated to simultaneously carry and break current to the ignition transformer, pilot valve, and main fuel valve(s).
6. All external timers must be listed or component recognized by authorities who have jurisdiction for the specific purpose for which they are used.

***IMPORTANT:***

1. *For on-off gas-fired systems, some authorities who have jurisdiction prohibit the wiring of any limit or operating contacts in series between the flame safeguard control and the main fuel valve(s).*
2. *Two Flame Detectors can be connected in parallel with the exception of Infrared Flame Detector (817-1742).*
3. *This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device of Part 15 of FCC rules which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area may cause interference; in which case, the users at their own expense may be required to take whatever measures are required to correct this interference.*
4. *This digital apparatus does not exceed the Class A limits for radio noise for digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.*

## Humidity

Install the CB780/CB784 where the relative humidity never reaches the saturation point. The CB780/CB784 is designed to operate in a maximum 85% RH continuous, noncondensing, moisture environment. Condensing moisture may cause a safety shutdown.

## Vibration

Do not install the CB780/CB784 where it could be subjected to vibration in excess of 0.5G continuous maximum vibration.

## Weather

The CB780/CB784 is not designed to be weather tight. If installed outdoors, the CB780/CB784 must be protected by an approved weather-tight enclosure.

## Mounting Wiring Subbase

NOTE: For installation dimensions, see Fig. 1.

1. Mount the subbase in any position except horizontally with the bifurcated contacts pointing down. The standard vertical position is recommended. Any other position decreases the maximum ambient temperature rating.
2. The 833-2725 Wiring Subbase can be mounted directly in the control cabinet. Be sure to allow adequate clearance for servicing, installation, access or removal of the CB780/CB784, Expanded Annunciator, Keyboard Display Module, flame amplifier, flame amplifier signal voltage probes, Run/Test Switch, electrical signal voltage probes and electrical field connections.
3. For surface mounting, use the back of the subbase as a template to mark the four screw locations. Drill the pilot holes.
4. Securely mount the subbase using four no. 6 screws.

# WIRING

1. Proper Wiring:
   a. For proper subbase wiring, refer to Fig. 7.
   b. For proper remote wiring of the Keyboard Display Module, refer to Fig. 8, 9 or 10 or to the Specifications for the Keyboard Display Module, Modbus™ Module or DATA CONTROLBUS MODULE™.
2. Disconnect the power supply from the main disconnect before beginning installation to prevent electrical shock and equipment damage. More than one disconnect may be involved.
3. All wiring must comply with all applicable electrical codes, ordinances and regulations. Wiring, where required, must comply with NEC, Class 1 (Line Voltage) wiring.
4. Recommended wire size and type:
   a. All Line Voltage terminals use no. 14 or 16 copper conductor (90°C or higher) 600 volt insulation wire (wire size must be coordinated with fuse protection). For high temperature installations, use wire selected for a temperature rating above the maximum operating temperature. All leadwires should be moisture resistant.
   b. Keyboard Display Module—For communications purposes, use an unshielded 22 AWG 2-wire twisted cable and one wire for ground if the leadwire run and noise conditions permit; however, some installations may need up to five wires, three for communications and two for remote reset (in either a single cable or separate cables for communications or remote reset) or use Belden 8771 shielded cable or equivalent. The Keyboard Display Module, DATA CONTROLBUS MODULE™ (for remote mounting or communications) or Modbus Module must be wired in a daisy chain configuration, (1(a)-1(a), 2(b)-2(b), 3(c)-3(c)). The order of interconnection of all the devices listed above is not important. Be aware that modules on the closest and farthest end of the daisy chain configuration string require a 120 ohm (1/4 watt minimum) resistor termination across terminals 1 and 2 of the electrical connectors, for connections over 100 feet, see Fig. 8, 9 and 10.
   c. DATA CONTROLBUS MODULE™—For communications purposes, use an unshielded 22 AWG 2-wire twisted cable if the leadwire run and noise

conditions permit; however, some installations may need up to five wires, three for communications and two for remote reset (in either a single cable or separate cables) or use a Belden 8771 shielded cable or equivalent. The Keyboard Display Module, DATA CONTROLBUS MODULE™ (for remote mounting or communications) or Modbus Module must be wired in a daisy chain configuration, (1(a)-1(a), 2(b)-2(b), 3(c)-3(c)). The order of interconnection of all the devices listed above is not important. Be aware that modules on the closest and farthest end of the daisy chain configuration string require a 120 ohm (1/4 watt minimum) resistor termination across terminals 1 and 2 of electrical connectors, for connections over 100 feet, see Fig. 8, 9 and 10.

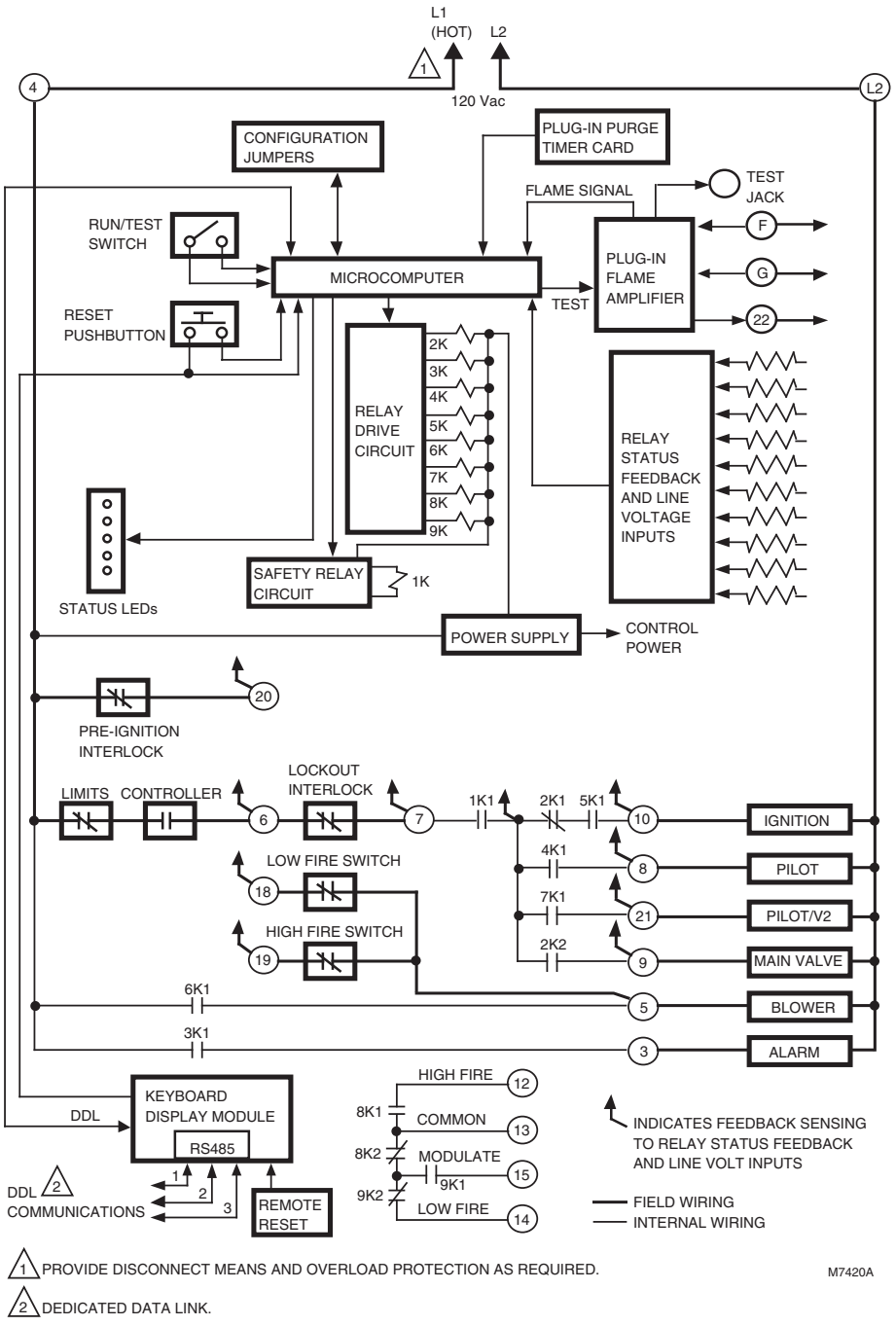



**Fig. 6. Internal block diagram of the CB780/CB784 (see Fig. 7, 8, 9, or 10 for detailed wiring instructions.**

d. Remote Reset—Use no. 22 AWG or greater twisted pair wire, insulated for low voltage; see Fig. 8, 9 and 10.
e. Use the recommended wire size for the 13 Vdc full wave rectified transformer power input of no. 18 AWG wire insulated for voltages and temperatures encountered in the application. Suggested wire types include TTW(60C), THW(75C) and THHN(90C).

**5.** Recommended grounding practices:
a. The earth ground provides for a connection between the subbase and the control panel of the equipment. The earth ground wire must be capable of conducting the current to blow the 20A fuse (or breaker) in event of an internal short circuit. The CB780/CB784 needs a low impedance ground connection to the equipment frame which, in turn, needs a low impedance connection to earth ground. For a ground path to be low impedance at RF frequencies, the connection must be made with minimum length conductors that have a maximum surface area. Wide straps or
brackets are preferred rather than leadwires. Be careful to ensure that mechanically tightened joints along the ground path, such as pipe or conduit threads or surfaces held together with fasteners, are free of nonconductive coatings and are protected against corrosion on mating surfaces.
b. Keyboard Display Module, DATA CONTROL BUS MODULE™ or Modbus™ Module—The shield, if used, should be connected to the signal ground terminal 3(c) provided as part of the CB780/CB784 device ControlBus connection. Connect the shield at both ends to earth ground.
c. CB780/CB784—Each CB780/CB784 will have an earth ground terminal that must be grounded to the metal control panel with wire as short as practical. Each ground wire must be capable of carrying a fault current equal to the rating of the protective fuse (20A). A number 14 copper conductor is adequate, but wide straps or brackets are preferred rather than leadwires.

**6.** Recommended wire routing:
a. Flame detector leadwires:
(1) Do not run high voltage ignition transformer wires in the same conduit with the flame detection wiring.
(2) Do not route scanner wires in conduit with line voltage circuits.
(3) Enclose scanner wires without armor cable in metal cable or conduit.
(4) Follow directions in flame detector Instructions.
b. DATA CONTROLBUS OR MODBUS MODULE™:
(1) Do not run high voltage ignition transformer wires in the same conduit or close proximity with the MODULE™ wiring.
(2) Do not route MODULE™ wires in conduit with line voltage circuits.
c. Keyboard Display Module (VFD): Because the VFD is powered from a low voltage, energy limited source, it can be mounted outside of a control panel if it is protected from mechanical damage.
d. Remote Reset:
(1) Do not run high voltage ignition transformer wires in the same conduit with the Remote Reset wiring.
(2) Do not route Remote Reset wires in conduit with line voltage circuits.

NOTE: A 13 Vdc power supply must be used any time more than one Keyboard Display Module is used.

**7.** Maximum wire lengths:
a. CB780/CB784 leadwires—The maximum length of leadwire is 300 feet to terminal inputs (Control, Preignition Interlock, Running/Lockout Interlock, High Fire Switch and Low Fire Switch).
b. Flame Detector leadwires—The maximum flame sensor leadwire length is limited by the flame signal strength.
c. Remote Reset leadwires—The maximum length of wire is 1000 feet to a Remote Reset pushbutton.
d. DATA CONTROLBUS or MODBUS MODULE™—The maximum module cable length depends on the number of system modules connected, the noise conditions and the cable used. The maximum length of all interconnecting wire is 1000 feet.

**8.** Make sure loads do not exceed the terminal ratings. Refer to the label on the CB780/CB784 or to the ratings in Specifications; see Table 1.
**9.** Check the power supply circuit. The voltage and frequency tolerance must match those of the CB780/CB784. A separate power supply circuit may be required for the CB780/CB784. Add the required disconnect means and overload protection.
**10.** Check all wiring circuits and complete the Static Checkout, see Table 8, before installing the CB780/CB784 on the subbase.
**11.** Install all electrical connectors.
**12.** Restore power to the panel.

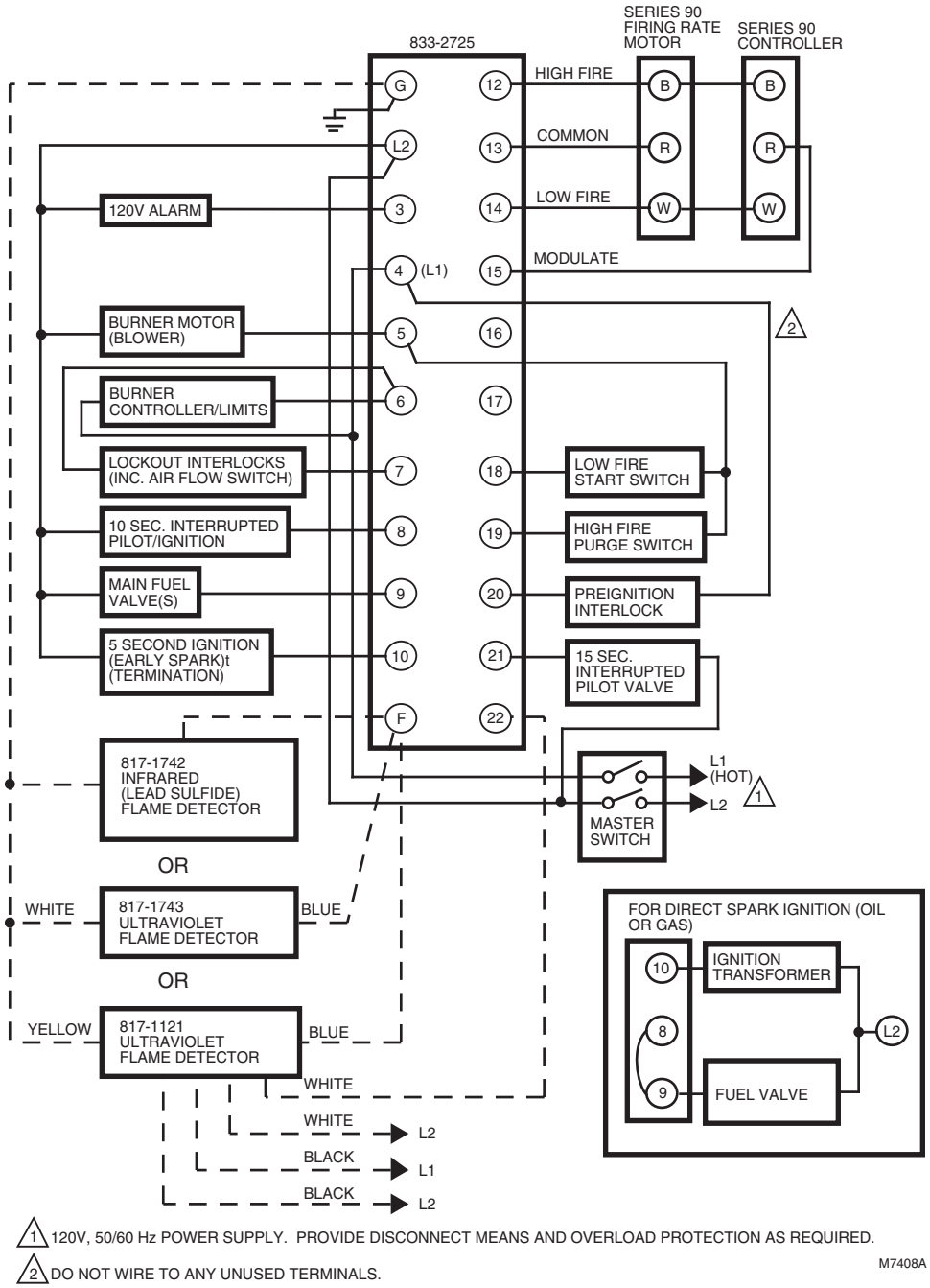
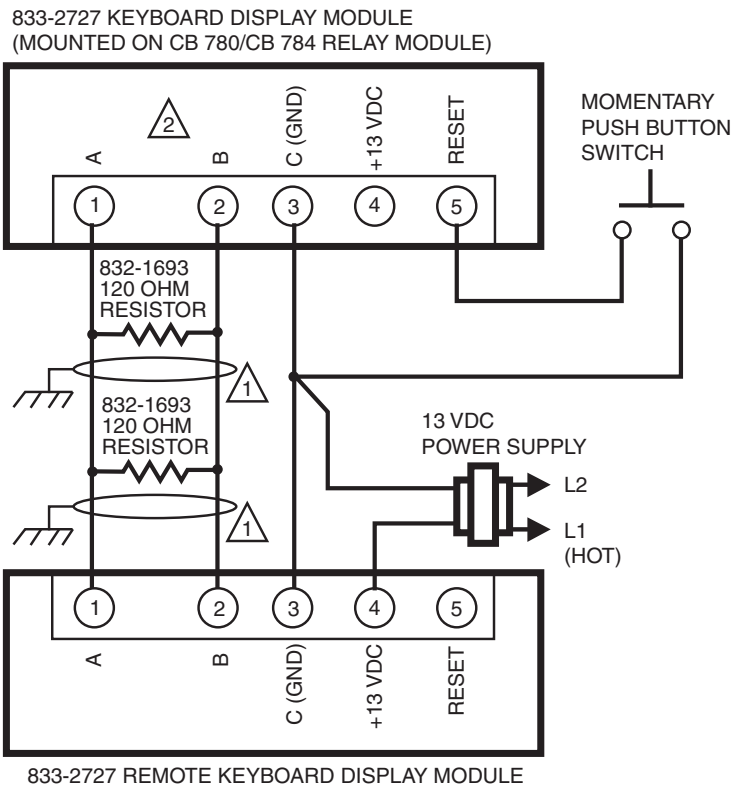



**Fig. 7. Wiring the CB780/CB784 Relay Module.**




1 THREE WIRE SHIELDED CABLE MAY BE REQUIRED. TWO 120 OHM TERMINATING RESISTORS ARE REQUIRED FOR CONNECTIONS OVER 100 FEET. CABLE SHIELD MUST BE TERMINATED TO EARTH GROUND AT BOTH ENDS. IF SHIELDED CABLE IS NOT USED, TWISTED PAIR WIRE MUST BE USED.

2 TERMINALS OF 833-2760 5-WIRE CONNECTOR (PROVIDED SEPARATELY).

M27263A

**Fig. 8. Wiring multiple Keyboard Display Modules.**

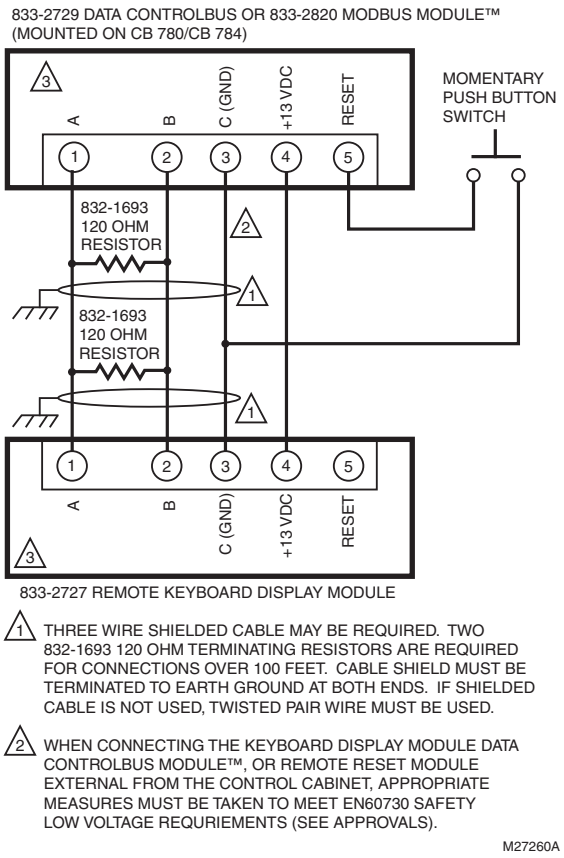



**Fig. 9. Wiring the Data ControlBus™ Module with Remote Keyboard Display Module.**

# ASSEMBLY

## Mounting CB780/CB784 Relay Modules

NOTE: For installation dimensions, see Fig. 1.

## Relay Module Mounting

1. Mount the CB780/CB784 vertically, see Fig. 11, or mount horizontally with the knife blade terminals pointing downward. The CB780/CB784 must be in an electrical enclosure.
2. Select the location in the electrical enclosure. Be sure to allow adequate clearance for servicing, installation and removal of the CB780/CB784, Keyboard Display Module, flame amplifier, flame amplifier signal voltage probes, electrical signal voltage probes, and electrical connections.
   a. Allow an additional two inches below the CB780/CB784 for the flame amplifier mounting.
   b. Allow an optional three-inch minimum to both sides of the CB780/CB784 for electrical signal voltage probes.
3. Make sure no subbase wiring is projecting beyond the terminal blocks. Tuck wiring in against the back of the sub-base so it does not interfere with the knife blade terminals or bifurcated contacts.

***IMPORTANT:***

*The CB780/CB784 must be installed with a plug-in motion rather than a hinge action.*

4. Mount the CB780/CB784 by aligning the four L shaped corner guides and knife blade terminals with the bifurcated contacts on the wiring subbase and tightening the two screws securely without deforming the plastic.

## Installing the Purge Card

1. Remove the Keyboard Display Module or DATA CONTROLBUS MODULE™, see Fig. 13 or 14.
2. Remove the current Purge Card from the CB780/CB784 by pulling the plastic support cover upward.
3. Make sure that the Purge Card selected has the desired timing.
4. Insert Purge Card into the opening of the CB780/CB784 compartment, see Fig. 12.

5. Reinstall the Keyboard Display Module or DATA CONTROLBUS MODULE™ onto the CB780/CB784 and restore power to the device.
6. Run the burner system through at least one complete cycle to verify the system is operating as desired.

**Fig. 10. Electrical panel installation.**

***IMPORTANT:***

*The CB780 will not function properly without one of the following mounted correctly: Keyboard Display Module, or DATA CONTROLBUS MODULE™.*

## Mounting Keyboard Display Module

1. Align the two interlocking ears of the Keyboard Display Module with the two mating slots on the CB780/CB784; see Fig. 13.
2. Insert the two interlocking ears into the two mating slots and with a hinge action push on the lower corners of the Keyboard Display Module to secure it to the CB780/CB784.
3. Verify the Keyboard Display Module is firmly in place.

## Mounting Data ControlBus™ Module

1. Align the two interlocking ears with the two mating slots on the CB780/CB784; see Fig. 14.
2. Insert the two interlocking ears into the two mating slots and push on the lower corners of the DATA CONTROLBUS MODULE™ to secure it to the CB780/CB784.
3. Be sure the DATA CONTROLBUS MODULE™ is firmly in place.

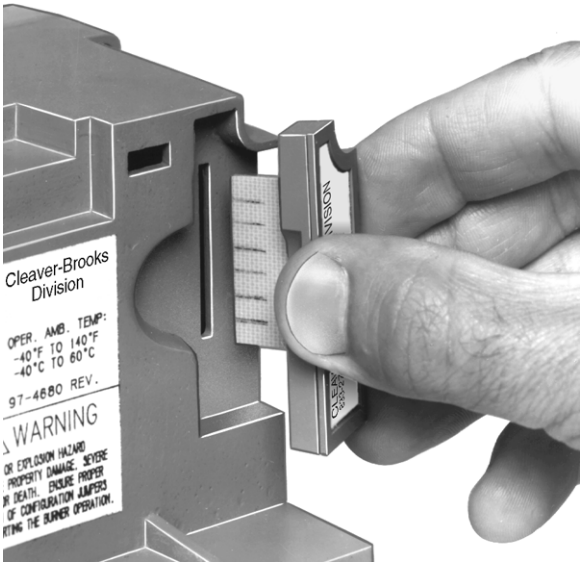



**Fig. 11. Purge card installation.**


**Fig. 12. Keyboard Display Module installation.**


**Fig. 13. Data ControlBus™ mounting.**

## Remote Mounting of Keyboard Display Module

1. The Keyboard Display Module can be mounted either on the face of a panel door or on other remote locations; see Fig. 15.
2. When mounting the Keyboard Display Module on the face of a door panel, closely follow these instructions:
   a. Select the location on the door panel for flush mounting. Pay attention to the insertion dimension of the two Keyboard Display Module screws, two interlocking ears and the two plug-in connectors to allow for sufficient clearance, 1/4 inch minimum inward from the surface of the door panel.
   b. Use the Keyboard Display Module as a template; see Fig. 28. Mark the two screw locations, two interlocking ear locations and two plug-in connector locations. Drill the pilot holes for the mounting screws. Provide for two holes on the door panel for the interlocking ears and plug-in connector holes.
   c. Mount the Keyboard Display Module securing the two no. 4 screws.
3. A second Keyboard Display Module or a Data ControlBus™ Module must be installed on the CB780/CB784. Connections from the module to the remote display are completed following wiring shown in Fig.8, 9, 10.

## Installing Plug-In Flame Signal Amplifier

1. Disconnect power supply before beginning installation to prevent electrical shock and equipment damage. More than one disconnect may be involved.
2. Align the amplifier circuit board edge connector with the keyed receptacle on the CB780/CB784. Verify the amplifier nameplate faces away from the Relay Module, see Fig. 16.
3. Push in the amplifier until the circuit board is fully inserted into the receptacle and then push the amplifier toward the CB780/CB784 retaining clasp.
4. Verify the amplifier is firmly in place.
5. Perform all required checkout tests.

## Installing the Flame Detector

NOTE: Table 2 lists the flame detection systems available for use with the CB780/CB784. Make sure the correct combination of amplifier and flame detector(s) is used.

Proper flame detector installation is the basis of a safe and reliable flame safeguard installation. Refer to the instructions packed with the flame detector and the equipment manufacturer instructions; see Fig. 17.

Keep the flame signal leadwires as short as possible from the flame detector to the wiring subbase. Capacitance increases with leadwire length, reducing the signal strength. The maximum permissible leadwire length depends on the type of flame detector, leadwire and conduit. The ultimate limiting factor in the flame detector leadwire is the flame signal; see Table 9.

**Fig. 14. Remote mounting of Keyboard Display Module.**


**Fig. 15. Flame signal amplifier mounting.**

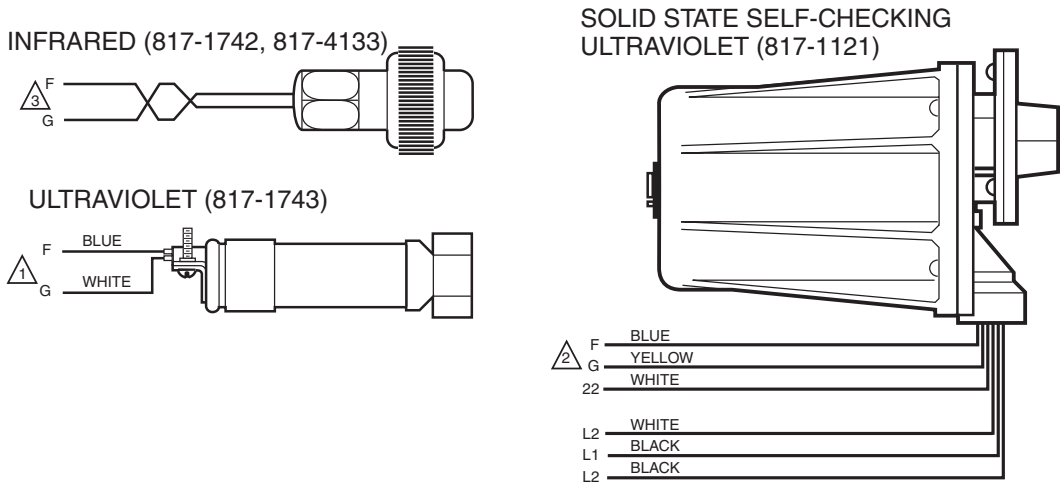



**Fig. 16. Flame detector wiring.**

# OPERATION

## Sequence of Operation

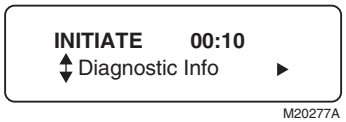
The CB780/CB784CB780/CB784 has the following operating sequence, see Fig. 18 and Table 4.

### INITIATE

The CB780/CB784 enters the INITIATE sequence when the Relay Module is powered. The CB780/CB784 can also enter the INITIATE sequence if the Relay Module verifies voltage fluctuations of +10/-15% or frequency fluctuations of ±10% during any part of the operating sequence. The INITIATE sequence lasts for ten seconds unless the voltage or frequency tolerances are not met. When the tolerances are not met, a hold condition will be initiated and will be displayed on the VFD for at least five seconds. When the tolerances are met, the INITIATE sequence will restart. If the condition is not corrected and the hold condition exists for four minutes, the CB780/CB784 will lockout. Causes for hold conditions in the INITIATE sequence:

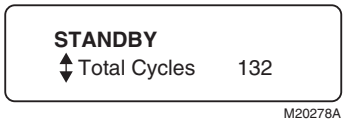
1. AC line dropout is detected.
2. AC line noise that can prevent a sufficient reading of the line voltage inputs.
3. Brownouts caused by a low line voltage.

The INITIATE sequence also delays the burner motor starter from being energized and de-energized from an intermittent AC line input or control input.




### STANDBY

The CB780/CB784 is ready to start an operating sequence when the operating control determines a *call for heat* is present. The burner switch, limits, operating control and all microcomputer monitored circuits must be in the correct state for the CB780/CB784 to continue into the PREPURGE sequence.




### NORMAL START-UP PREPURGE

The CB780/CB784 provides a PREPURGE timing selectable from 30 seconds to 2-1/2 minutes with power applied and the CB780/CB784 operating control indicating a *call for heat*:

Running Interlocks, Preignition Interlocks, Burner Switch, Run/Test Switch, Lockout Interlocks and all microcomputer monitored circuits must be in the correct operating state.

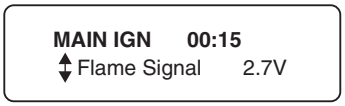
1. The blower motor output, terminal 5, is powered to start the PREPURGE sequence. The firing rate motor is driven to the high fire position. The PREPURGE timing does not begin until the Lockout Interlock String and High Fire Switch are both closed.
2. The Preignition Interlock input must remain closed throughout PREPURGE; otherwise, safety shutdown occurs.

3. The Lockout Interlock or Running Interlock inputs (interlock circuit including Airflow Switch) must close by ten seconds into PREPURGE; otherwise, a safety shutdown occurs.
4. After the firing rate motor reaches the PREPURGE rate position and PREPURGE timing is completed, the firing rate motor will drive to the low fire position.
5. When the firing rate motor reaches low fire position, the Low Fire Switch, terminal 18, input must be energized before entering the Ignition Trial state.

## IGNITION TRIALS

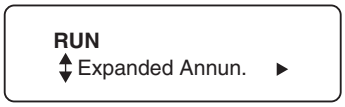

Pilot Flame Establishing Period (PFEP):

1. With the firing rate motor at the low fire position:
   a. The pilot valve and the ignition transformer, terminals 8, 10 and 21, are energized. The CB780/CB784 has a fifteen second interrupted pilot valve, terminal 21 and a ten second interrupted pilot valve/ignition, terminal 8.
   b. During PFEP, the Low Fire Switch must remain closed. If it opens, a safety shutdown occurs.
   c. The Preignition Interlock input is ignored throughout the Ignition Trial state.
2. Flame must be proven by the end of the four or ten second PFEP to allow the sequence to continue. If flame is not proven by the end of PFEP, a safety shutdown occurs.
3. With flame proven, the ignition, terminal 10, is de-energized for early spark termination.




4. Main Flame Establishing Period (MFEP):
   a. The CB780/CB784 has a selectable ten second or fifteen second MFEP. After the Ignition Trials, and with the presence of flame, the main fuel valve, terminal 9, is powered. If a flameout occurs, the CB780/CB784 will lockout within 3 seconds.

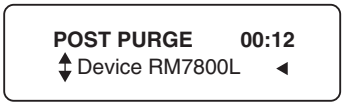
## RUN




A ten second stabilization period occurs at the beginning of the RUN period.

1. The firing rate motor releases to modulation.
2. The CB780/CB784 is now in RUN and will remain in RUN until the controller input, terminal 6, opens, indicating that the demand is satisfied or a limit has opened.

## POSTPURGE




The CB780/CB784 provides a fifteen second POST-PURGE following the completion of the RUN period. The blower motor output is powered to drive all products of combustion and any unburned fuel from the combustion chamber. It also supplies combustion air to burn fuel being purged from the fuel line downstream of the fuel shutoff valve.

1. The main fuel valve and intermittent pilot valve, terminals 9 and 21, are de-energized and the firing rate motor is commanded to the low fire position to begin the POSTPURGE period.
2. The Preignition Interlock closes within the first five seconds of POSTPURGE.
3. After the fifteen second POSTPURGE period is completed, the CB780/CB784 reenters STANDBY.

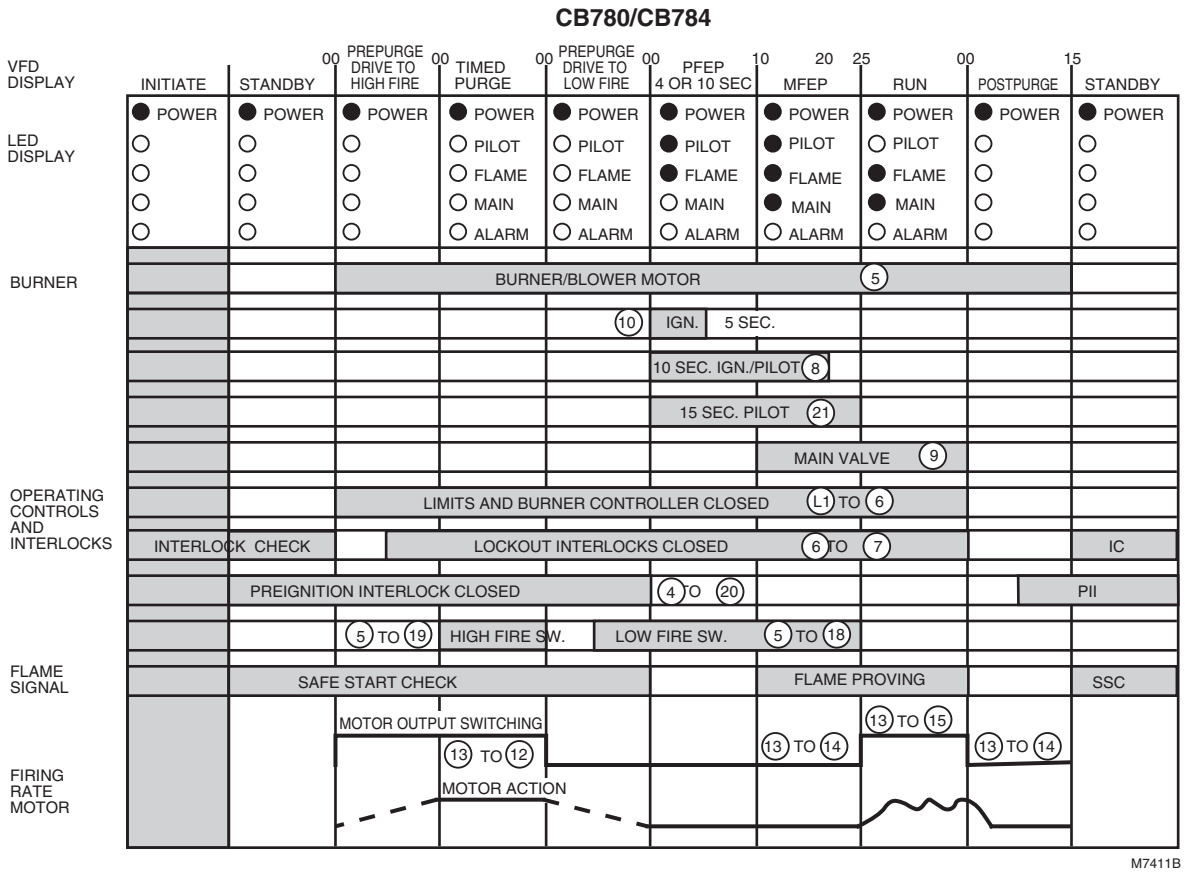



**Fig. 17. CB780/CB784 sequence.**

## KEYBOARD DISPLAY MODULE (KDM)

The first line of the Keyboard Display Module provides current status of the burner sequence (STANDBY, PURGE, PILOT IGN, MAIN IGN, RUN and POST-PURGE), timing information (PURGE, PILOT IGN, MAIN IGN and POSTPURGE) in minutes and seconds, hold information (PURGE HOLD: T19) and lockout information (Lockout, Fault Code, Message and Sequence); see Fig. 19. The extreme right side of the first line will either be blank or it will show a small arrow pointing to the second line followed by a two-letter code (DI-Diagnostic Information, Hn-Fault History Information, and EA-Expanded Annunciator). When the arrow and two-letter code are displayed, it indicates the second line is showing a selectable message submenu. The second line will display selectable or preemptive messages. A selectable message supplies information for flame strength, system status indication, system or self-diagnostics and troubleshooting. A preemptive message will have parentheses around the message and supply a detailed message to support the sequence status information. A preemptive message can also be a lockout message. A preemptive message will replace a selectable message to support the sequence status information. It will also replace a selectable message after 60 seconds if it or a lockout message is available. The CB780/CB784 LEDs provide positive visual indication of the program sequence: POWER, PILOT, FLAME, MAIN and ALARM.

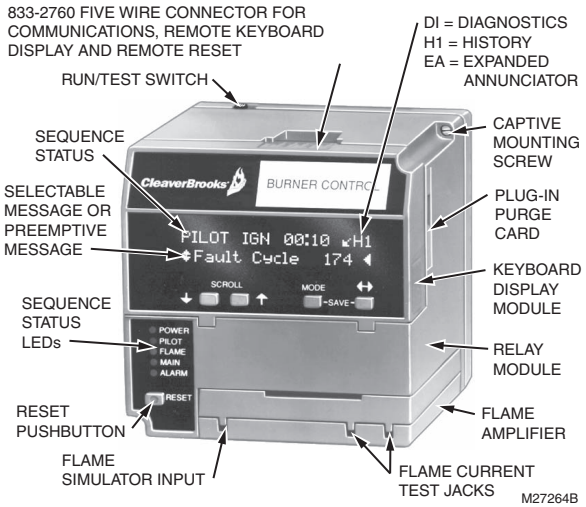



**Fig. 18. Keyboard Display Module and sequence status LEDs (Table 4).**

NOTE: Normal sequences (in Table 4) are in BOLD TYPE, while abnormal sequences are not in bold type.

**Table 4. Sequence Status Display Information (see Fig. 19).**

| Burner Sequence | LEDs Energized (BOLD type) |
|---|---|
| INITIATE minutes:seconds selectable —message | POWER, PILOT, FLAME, MAIN AND ALARM |
| INITATE HOLD: AC (AC Freq/Noise) | POWER, PILOT, FLAME, MAIN AND ALARM |
| INITIATE HOLD: AC (AC Line Dropout) | POWER, PILOT, FLAME, MAIN AND ALARM |
| INITIATE HOLD: AC (AC Frequency) | POWER, PILOT, FLAME, MAIN AND ALARM |
| INITIATE HOLD: AC (Low Line Voltage) | POWER, PILOT, FLAME, MAIN AND ALARM |
| STANDBY selectable—message | POWER, PILOT, FLAME, MAIN AND ALARM |
| STANDBY HOLD: REM (Remote Control) | POWER, PILOT, FLAME, MAIN AND ALARM |
| STANDBY HOLD: F/G (Flame Detected) | POWER, PILOT, FLAME, MAIN AND ALARM |
| STANDBY HOLD: (Preignition ILK) | POWER, PILOT, FLAME, MAIN AND ALARM |
| STANDBY HOLD: (Lockout ILK) | POWER, PILOT, FLAME, MAIN AND ALARM |
| PURGE HOLD: (High Fire Switch) | POWER, PILOT, FLAME, MAIN AND ALARM |
| PURGE DELAY (High Fire Jumprd) | POWER, PILOT, FLAME, MAIN AND ALARM |
| PURGE HOLD: TEST (Run/Test Switch) | POWER, PILOT, FLAME, MAIN AND ALARM |
| PURGE DELAY: (Low Fire Jumprd) | POWER, PILOT, FLAME, MAIN AND ALARM |
| PURGE HOLD: F/G (Flame Detected) | POWER, PILOT, FLAME, MAIN AND ALARM |
| PURGE HOLD: (Low Fire Switch) | POWER, PILOT, FLAME, MAIN AND ALARM |
| PILOT IGN minutes:seconds selectable—message | POWER, PILOT, FLAME, MAIN AND ALARM |
| PILOT HOLD: TEST (Run/Test Switch) | POWER, PILOT, FLAME, MAIN AND ALARM |
| MAIN IGN minutes:seconds selectable—message | POWER, PILOT, FLAME, MAIN AND ALARM |
| RUN selectable—message | POWER, PILOT, FLAME, MAIN AND ALARM |
| RUN selectable—message | POWER, PILOT, FLAME, MAIN AND ALARM |
| RUN LOWFIRE:TEST (Run/Test Switch) | POWER, PILOT, FLAME, MAIN AND ALARM |
| POSTPURGE minutes:seconds selectable—message | POWER, PILOT, FLAME, MAIN AND ALARM |
| Waiting for connection... | POWER, PILOT, FLAME, MAIN AND ALARM |
| RESET/ALARM TEST selectable—message | POWER, PILOT, FLAME, MAIN AND ALARM |
| Additional sequence status information when an Expanded Annunciator is connected to the relay module, also see CB780/CB784 System Annunciation Diagnostics and Troubleshooting, Bulletin Number CB-7803. | |
| BURNER OFF: (Burner Switch) | POWER, PILOT, FLAME, MAIN AND ALARM |
| STANDBY HOLD: (Expanded Annunciator hold message) | POWER, PILOT, FLAME, MAIN AND ALARM |
| STANDBY HOLD: (Circuit Fault) | POWER, PILOT, FLAME, MAIN AND ALARM |

## Keyboard Functions

The keyboard contains four pushbuttons and each has separate functions (SCROLL-Down, SCROLL-Up, MODE and Change-Level). The MODE and Change-Level pushbuttons, when pressed together, provide a SAVE function.

1. SCROLL Down-Up pushbuttons (o), see Fig. 20.
2. Change Level pushbutton («), see Fig.21.
   The Change-Level pushbutton is used to change between the first hierarchy of selectable messages to a subset of selectable messages. The Change-Level pushbutton can also be used to change from a subset message to a first level selectable message. The symbol (>) located on the second line in the lower right corner of the KDM represents a first level hierarchy of selectable messages. The symbol (<) located on the second line in the lower right corner of the KDM represents a subset of selectable messages.
3. MODE pushbutton, see Fig. 22.
   The MODE pushbutton instantaneously switches the display from a *second-line-selectable* message to *second-line-preempted* message. The sixty second timeout function also can be used for this task. The MODE pushbutton will work only if there is a *second-line-preempted* message or lockout message.
4. SAVE function; see Fig. 23.
   The SAVE function enables users to identify the selectable message they want to view upon power restoration. The second line selectable message will be restored to the most recently saved selection when power returns. The SAVE function is performed by pressing and holding the MODE key and then pressing the Change-Level pushbutton («). The second line of the display will briefly note "...SAVING..." to confirm the key press.

## Selectable Messages

KDM Second Line Display, Two-Level Hierarchy, see Table 5.

The display values are as follows:

n represents a numbered value.

T represents the terminal number.

x represents the suffix letter of the Relay Module.

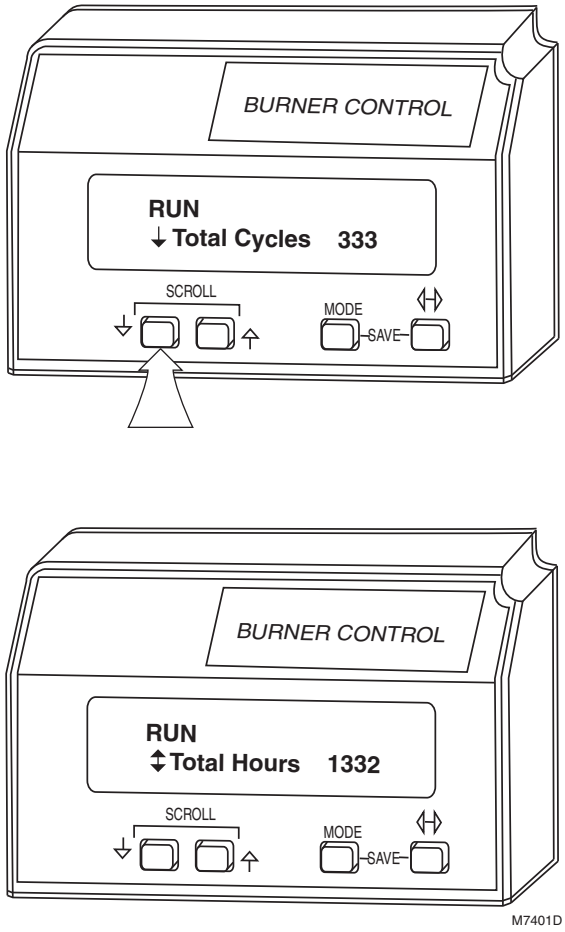



**Fig. 19. SCROLL pushbutton function.**

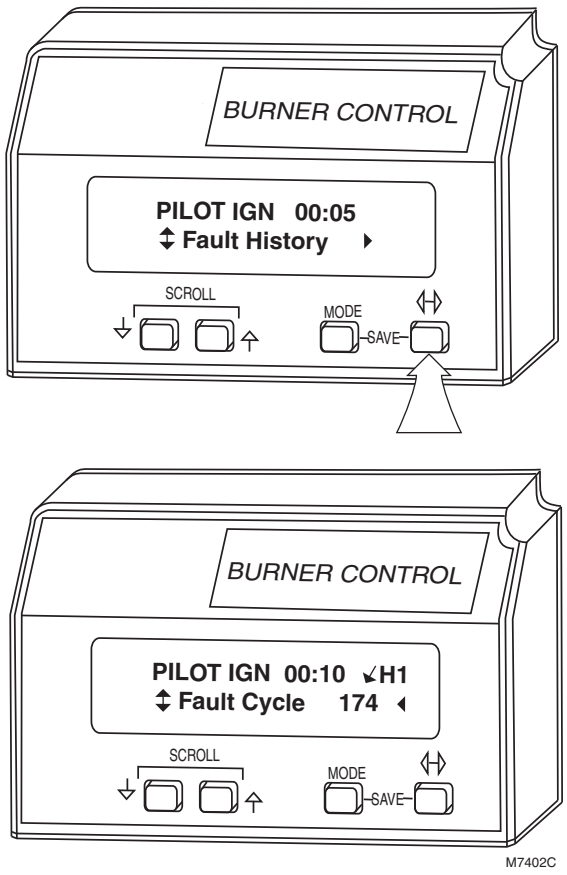



**Fig. 20. Change Level pushbutton function.**

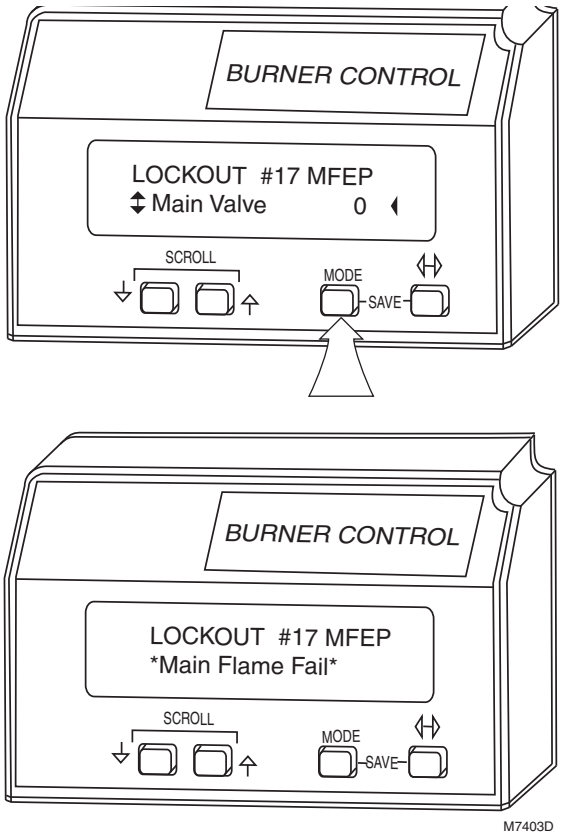



**Fig. 21. MODE pushbutton function.**

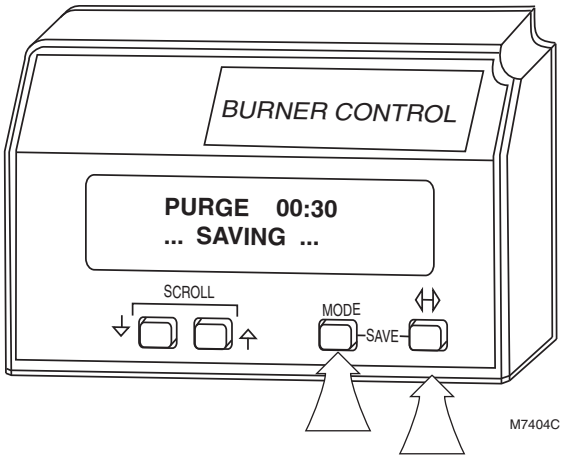



**Fig. 22. SAVE function.**

**Table 5. Selectable Messages.**

| Selectable Message (Second Line) | Display Value (Second Line) | First Line Message |
|---|---|---|
| ↕Flame Signal | n.nV | |
| ↕Total Cycles | nnnnn | |
| ↕Total hours | nnnnn | |
| ↕Fault History | | |
| ↕Fault Cycle ◄► | nnnnn < H1 ↓ | |
| ↕Fault Hours | nnnnn < H1 ↓ | |
| ↕Fault Code | nnn < | ↓ H1 |
| ↕*fault—message* | | ↓ H1 |
| ↕sequence—message< | | ↓ H1 |
| ↕(second-line-msg)< | | ↓ H1 |
| ↕Fault Cycle | nnnnn <H2 ↓ | |
| ↕Fault Hours | nnnnn <H2 ↓ | |
| ↕Fault Code | nnn < | ↓ H2 |
| ↕*fault—message*< | | ↓ H2 |
| ↕sequence—message< | | ↓ H2 |
| ↕(second-line-msg)< | | ↓ H2 |
| ↕Fault Cycle | nnnnn <H3 ↓ | |
| ↕Fault Hours | nnnnn <H3 ↓ | |
| ↕Fault Code | nnn < | ↓ H3 |
| ↕*fault—message*< | | ↓ H3 |
| ↕sequence—message< | | ↓ H3 |
| ↕(second-line-msg)< | | ↓ H3 |
| ↕Fault Cycle | nnnnn <H4 ↓ | |
| ↕Fault Hours | nnnnn <H4 ↓ | |
| ↕Fault Code | nnn < | ↓ H4 |
| ↕*fault—message*< | | ↓ H4 |
| ↕sequence—message | | ↓ H4 |
| ↕(second-line-msg) | | ↓ H4 |
| ↕Fault Cycle | nnnnn <H5 ↓ | |
| ↕Fault Hours | nnnnn <H5 ↓ | |
| ↕Fault Code | nnn < | ↓ H5 |
| ↕*fault—message*< | | ↓ H5 |
| ↕sequence—message | | ↓ H5 |
| ↕(second-line-msg) | | ↓ H5 |
| ↕Fault Cycle | nnnnn <H6 ↓ | |
| ↕Fault Hours | nnnnn <H6 ↓ | |
| ↕Fault Code | nnn < | ↓ H6 |
| ↕*fault—message*< | | ↓ H6 |
| ↕sequence—message | | ↓ H6 |
| ↕(second-line-msg) | | ↓ H6 |

**Table 5. Selectable Messages. (Continued)**

| Selectable Message (Second Line) | Display Value (Second Line) | First Line Message |
|---|---|---|
| ↕Diagnostic Info ◄► | | |
| ↕Device | RM78nnx < | ↓ DI |
| ↕Device Suffix | nnnn < | ↓ DI |
| ↕Run/Test Sw. | RUN or TEST < | ↓ DI |
| ↕Operating Control (OperControl) | 1 or 0 < | ↓ DI |
| ↕Interlock | 1 or 0 < | ↓ DI |
| ↕Pilot Valve | 1 or 0 < | ↓ DI |
| ↕Main Valve | 1 or 0 < | ↓ DI |
| ↕Ignition | 1 or 0 < | ↓ DI |
| ↕Low Fire Sw | 1 or 0 < | ↓ DI |
| ↕High Fire Sw | 1 or 0 < | ↓ DI |
| ↕Preignition Interlock (PreIgn ILK) | 1 or 0 < | ↓ DI |
| ↕Pilot Valve/First State Oil Valve(Valv/Start, V25) | 1 or 0 < | ↓ DI |
| ↕Jumper 1 | INTACT or CLIPPED < | ↓ DI |
| ↕Jumper 2 | INTACT or CLIPPED < | ↓ DI |
| ↕Jumper 3 | INTACT or CLIPPED < | ↓ DI |
| ↕Amplifier Type (Amp Type) | NORMAL or AMP-CHECK or SHUTTER | ↓ DI |
| ↕Flame Response | 0.8s or 3s < | ↓ DI |
| ↕Purge Time | mm:ss < | ↓ DI |
| ↕Manufacturing Code (Mfg Code) | nnnn < | ↓ DI |
| ↕Software Revision (SW Rev.) | nnnn/nnnn < | ↓ DI |
| ↕Expanded Annun. (see Table 6) ◄► | | |
| ↕Remote Command | NONE/HOLD/HF/LF | |

## Expanded Annunciator Messages (See Table 6)

The Expanded Annunciator (EA) may or may not be connected because it is an optional device. If the EA is not connected, a display message of “(EA not connected)” will be shown. If the EA is connected, display messages will be shown, see Table 6 and CB780/CB784 System Annunciation Diagnostics and Troubleshooting, Bulletin Number CB-7803, Tables 6 and 7 for fault codes. When accessing Expanded Annunciator Messages, follow the same operations as used with the Selectable Messages.

**Table 6. Expanded Annunciator Messages.**

| Selectable Message (Second Line) | Display Value (Second Line) | First Line Message |
|---|---|---|
| ↕Expanded Annun. ◄► | | |
| ↕Expanded Annunciator (EA not connected)< | | |
| ↕Current status (CS:)[a] | EA Message< | |
| ↕Valve Closure (Valve Close) | T4 1 or 0< | ↓ EA |
| ↕Burner Switch (Burner Sw.) | T5 1 or 0< | ↓ EA |
| ↕Operating Control (OperControl) | T6 1 or 0< | ↓ EA |
| ↕Auxiliary Limit (Aux Limit 1) | T7 1 or 0< | ↓ EA |
| ↕Auxiliary Limit (Aux Limit 2) | T8 1 or 0< | ↓ EA |
| ↕Low Water Cutoff (LWCO) | T9 1 or 0< | ↓ EA |
| ↕High Limit (High Limit) | T10 1 or 0< | ↓ EA |
| ↕Auxiliary Limit (Aux Limit 3) | T11 1 or 0< | ↓ EA |
| ↕Oil Selection Switch (Oil Select) | T12 1 or 0< | ↓ EA |
| ↕High Oil Pressure Switch (HiOilPres) | T13 1 or 0< | ↓ EA |
| ↕Low Oil Pressure Switch (LowOilPres) | T14 1 or 0< | ↓ EA |
| ↕High Oil Temperature Switch (HiOilTemp) | T15 1 or 0< | ↓ EA |
| ↕Low Oil Temperature Switch (LowOilTemp) | T16 1 or 0< | ↓ EA |
| ↕Atomizing Switch (Atomize Sw) | T19 1 or 0< | ↓ EA |
| ↕Gas Selection Switch (Gas Select) | T17 1 or 0< | ↓ EA |
| ↕High Gas Pressure Switch (Hi GasPres) | T18 1 or 0< | ↓ EA |
| ↕Low Gas Pressure Switch (LowGasPres) | T19 1 or 0< | ↓ EA |
| ↕Airflow Switch (Airflow Sw) | T20 1 or 0< | ↓ EA |
| ↕Auxiliary Interlock (Aux ILK 4) | T21 1 or 0< | ↓ EA |
| ↕Auxiliary Interlock (Aux ILK 5) | T22 1 or 0< | ↓ EA |
| ↕EA Fault Code | nnn< | ↓ EA |
| ↕Software Revision (SW Rev.) | nnnn< | ↓ EA |

[a] Expanded Annunciator Diagnostic Current Status Messages can be reviewed in CB780/CB784 System Annunciation Diagnostics and Troubleshooting, Bulletin Number CB-7803.

## Run/Test Switch Functions

The Run/Test Switch is located on the top side of the CB780/CB784; see Fig. 19. The Run/Test Switch allows the burner sequence to be altered as follows:

1. In Prepurge Drive To High Fire Position, the Run/Test Switch, when placed in the TEST position, will hold in PREPURGE with the firing rate motor in the High Fire position.
2. In the measured PREPURGE sequence, the Run/Test Switch, when placed in the TEST position, will cause the PREPURGE timing to stop. The firing rate motor will be in the High Fire position.
3. In Prepurge Drive to Low Fire position, the Run/Test Switch, when placed in the TEST position, will hold the burner sequence in PREPURGE with the firing rate motor in the Low Fire position.
4. In PFEP, the Run/Test Switch, when placed in the TEST position, will stop the timer during the first eight seconds when a ten second PFEP is selected or during the first three seconds when a four second PFEP is selected, allowing pilot-turn-down test and other burner adjustments to be made. This activates a fifteen second flameout timer that permits pilot flame adjustment without nuisance safety shut-downs. The Run/Test Switch will be ignored during PFEP for the CB780/CB784 if terminals 8 and 9 or 9 and 21 are jumpered.
5. During RUN, the Run/Test Switch, when placed in the TEST position, will drive the firing rate motor to the Low Fire position.

NOTE: When CB780/CB784 is switched to the TEST mode, it will stop and hold at the next Run/Test Switch point in the operating sequence. *Make sure that the Run/Test Switch is in the RUN position before leaving the installation.*

## Selectable Site-Configurable Jumpers

The CB780/CB784 has two site-configurable jumper options; see Fig. 24 and Table 7. The site-configurable jumpers should be clipped with side cutters and the resistors removed from the Relay Module.

**Table 7. Site Configurable Jumper Options.**

| Jumper Number | Description | Intact | Clipped |
|---|---|---|---|
| JR1 | Pilot Flame Establishing Period (PFEP) | 10 seconds | 4 seconds |
| JR3 | Start-up Interlock Check | Disabled | Enabled |

NOTE: For all standard installations, these jumpers should be left intact, unless otherwise indicated on wiring diagram. Removal after 200 hours of operation will result in a hard lockout, Code 110.

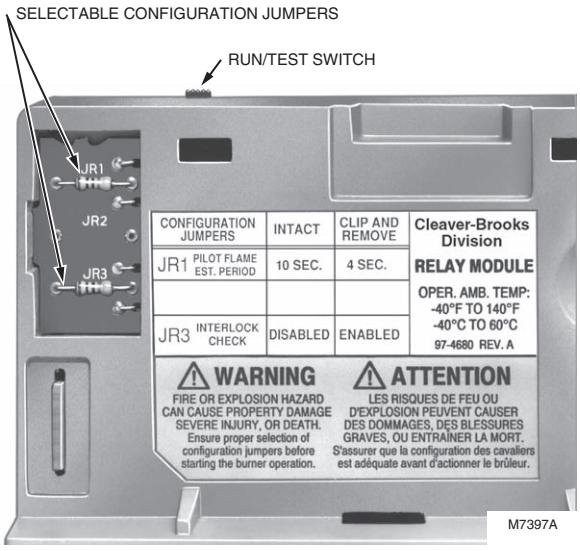



**Fig. 23. Selectable site-configurable jumpers.**

# STATIC CHECKOUT

## ⚠ WARNING

**Electrical Shock Hazard and Explosion Hazard. Can cause severe injury, death or property damage.**

1. Use extreme care while testing the system. Line voltage is present on most terminal connections when power is on.
2. Open the master switch before installing or removing a jumper on the subbase.
3. Before continuing to the next test, be sure to remove test jumper(s) used in the previous test.
4. Replace all limits and interlocks that are not operating properly. Do not bypass limits and interlocks.
5. Close all manual fuel shutoff valve(s) before starting these tests.

After checking all wiring, perform this checkout before installing the CB780/CB784 on the subbase. These tests verify the Wiring Subbase is wired correctly, and the external controllers, limits, interlocks, actuators, valves, transformers, motors and other devices are operating properly.

NOTE: Do not perform a dielectric test with theCB780/CB784 installed. Internal surge protectors will break down and conduct a current. This could cause the CB780/CB784 to fail the dielectric test or possibly destroy the internal lightning and high current protection.

## Equipment Recommended

1. Voltmeter (1 megohm/volt minimum sensitivity) set on the 0-300 Vac scale.
2. Two jumper wires; no. 14 wire, insulated, 12 inches (304.8 mm) long with insulated alligator clips at both ends.

## General Instructions

1. Perform all applicable tests listed in Static Checkout, Table 8, in the order listed.
2. *Make sure all manual fuel shutoff valve(s) are closed.*
3. Raise the setpoint of the operating controller to simulate a *call for heat*.
4. For each test, open the master switch and install the jumper wire(s) between the subbase wiring terminals listed in the Test Jumpers column.
5. Close the master switch before observing operation.
6. Read the voltage between the subbase wiring terminals listed in the Voltmeter column.
7. If there is no voltage or the operation is abnormal, check the circuits and external devices as described in the last column.
8. Check all wiring for correct connections, tight terminal screws, correct wire, and proper wiring techniques. Replace all damaged or incorrectly sized wires.
9. Replace faulty controllers, limits, interlocks, actuators, valves, transformers, motors and other devices as required.
10. Ensure normal operation is obtained for each required test before continuing the checkout.
11. After completing each test, be sure to remove the test jumper(s).

**Table 8. Static Checkout.**

| Test No. | Test Jumpers | Volt-meter | Normal Operation | If Operation is Abnormal, Check the Items Listed Below |
|---|---|---|---|---|
| **⚠ WARNING**<br>**Explosion Hazard.**<br>**Can cause severe injury, death or property damage.**<br>Make sure all manual fuel shutoff valves are closed.<br><br>***IMPORTANT:***<br>*Low fuel pressure limits, if used, could be open. Bypass them with jumpers for the remaining Static Tests (if required).* | | | | |
| 1 | None | 4-L2 | Line voltage at terminal 4. | **1.** Master switch.<br>**2.** Power connected to the master switch.<br>**3.** Overload protection (fuse, circuit breaker, etc.) has not opened the power line. |
| 2 | None | 6-L2 | Line voltage at terminal 6. | **1.** Limits.<br>**2.** Burner controller. |
| 3 | None | 20-L2 | Line voltage at terminal 20. | **1.** Preignition interlocks. |
| 4 | 4-5 | 7-L2 | **1.** Burner motor (fan or blower) starts.<br>**2.** Line voltage at terminal 7 within 10 seconds. | **1.** Burner motor circuit.<br>a. Manual switch of burner motor.<br>b. Burner motor power supply, overload protection, and starter.<br>c. Burner motor.<br>**2.** Running or Lockout Interlocks (including Airflow Switch). |
| 5 | 4-10 | — | Ignition spark (if ignition transformer is connected to terminal 10). | **1.** Watch for spark or listen for buzz.<br>a. Ignition electrodes are clean.<br>b. Ignition transformer is okay. |
| 6 | 4-8 | — | **1.** Ignition spark (if ignition transformer is connected to terminal 8).<br>**2.** Automatic pilot valve opens (if connected to terminal 8).<br><br>NOTE: Refer to wiring diagram of system being tested. | **1.** Watch for spark or listen for buzz.<br>a. Ignition electrodes are clean.<br>b. Ignition transformer is okay.<br>**2.** Listen for click or feel head of valve for activation.<br>a. Actuator, if used.<br>b. Pilot valve. |
| 7 | 4-21 | — | Same as test no. 6 for connections to terminal 8. If using direct spark ignition, check the first stage fuel valve(s) instead of pilot valve. | Same as test no. 6. If using direct spark ignition, check the first stage fuel valve(s) instead of the pilot valve. |
| 8 | 4-9 | — | Automatic main fuel valve(s) open. If using direct spark ignition with intermittent pilot on terminal 21, check the optional second stage fuel valve, if used. | **1.** Listen for and observe operation of the main fuel valve(s) and actuator(s).<br>**2.** Valve(s) and actuator(s). |
| 9 | 4-3 | — | Alarm (if used) turns on. | **1.** Alarm. |
| 10 | 4-5 and 12-13 | 18-L2 | Firing rate motor drives open; zero volts at terminal 18 after motor starts driving open. | **1.** Low Fire Start Switch.<br>**2.** Firing rate motor and transformer. |
| 11 | 4-5 and 14-13 | 18-L2 | Firing rate motor drives closed; line voltage at terminal 18 after motor is in Low Fire position. | **1.** Low Fire Start Switch.<br>**2.** Firing rate motor and transformer. |
| 12 | 4-5 and 12-13 | 19-L2 | Firing rate motor drives open; line voltage at terminal 19 after motor is in High Fire position. | **1.** High Fire Purge Switch.<br>**2.** Firing rate motor and transformer. |

**Table 8. Static Checkout. (Continued)**

| Test No. | Test Jumpers | Volt-meter | Normal Operation | If Operation is Abnormal, Check the Items Listed Below |
|---|---|---|---|---|
| 13 | 4-5 and 14-13 | 19-L2 | Firing rate motor drives closed; zero volts at terminal 19 after motor starts driving closed. | **1.** Low Fire Start Switch.<br>**2.** Firing rate motor and transformer. |
| **⚠ WARNING**<br>**Explosion Hazard.**<br>**Can cause severe injury, death or property damage.**<br>Make sure all manual fuel shutoff valves are closed.<br><br>***IMPORTANT:***<br>*Low fuel pressure limits, if used, could be open. Bypass them with jumpers for the remaining Static Tests (if required).* | | | | |
| 14 | 15-13 | — | **1.** Raise set point of Series 90 controller—firing rate motor should drive toward open.<br>**2.** Lower set point of Series 90 controller—firing rate motor should drive toward closed. | **1.** Series 90 Controller.<br>**2.** Firing rate motor and transformer. |
| Final | **⚠ CAUTION**<br>**Equipment Damage Hazard.**<br>**Failure to remove test and bypass jumpers can damage equipment or affect operation.**<br>On completing these tests, open the master switch and remove all test jumpers from the subbase terminals. Also, remove bypass jumpers from the low fuel pressure limits (if used). | | | |

# CHECKOUT

**⚠ WARNING**
**Explosion Hazard.**
**Can cause severe injury, death or property damage.**
Do not allow fuel to accumulate in the combustion chamber. If fuel is allowed to enter the chamber for longer than a few seconds without igniting, an explosive mixture could result. It is recommended that you limit the trial for pilot to ten seconds, and limit the attempt to light the main burner to two seconds from the time the fuel has reached the burner nozzle. In any case, do not exceed the nominal lightoff time specified by the equipment manufacturer; close the manual fuel shutoff valve(s) if the flame is not burning at the end of the specified time.

**⚠ WARNING**
**Electrical Shock Hazard and Explosion Hazard.**
**Can cause severe injury, death or property damage.**
1. Use extreme care while testing the system. Line voltage is present on most terminal connections when power is on.
2. Open the master switch before removing or installing the CB780/CB784 or Keyboard Display Module connector.
3. Make sure all manual fuel shutoff valve(s) are closed before starting the initial lightoff check and the Pilot Turndown tests.
4. Do not put the system in service until you have satisfactorily completed all applicable tests in this section and any others required by the equipment manufacturer.

***IMPORTANT:***
1. *If the system fails to perform properly, note the fault code, fault message, equipment status, and sequence time on the display. Refer to the Troubleshooting section and CB780/CB784 System Annunciation Diagnostics and Troubleshooting, Bulletin Number CB-7803.*
2. *Repeat ALL required Checkout tests after all adjustments are made. ALL tests must be satisfied with the flame detector(s) in its FINAL position.*

## Equipment Recommended:

**1.** Volt-ohmmeter (one megohm/volt minimum sensitivity) with:
   a. 0-300 Vac capability.
   b. 0-6000 ohm capability.
   c. 0-10 Vdc capability.

## Checkout Summary

**1.** Preliminary inspection—all installations.
**2.** Flame signal measurement—all installations.
**3.** Initial lightoff check for proved pilot—all installations using a pilot.

4. Initial lightoff check for direct spark ignition of oil—all burners using DSI.
5. Pilot turndown test—all installations using a pilot.
6. Hot refractory saturation test—all installations using Infrared (lead sulfide) Flame Detectors.
7. Hot refractory hold-in test—all installations.
8. Ignition interference test—all installations using flame rods.
9. Ignition spark pickup—all installations using Ultraviolet Flame Detectors.
10. Response to other ultraviolet sources—all installations using Ultraviolet Flame Detectors.
11. Flame signal with hot combustion chamber—all installations.
12. Safety shutdown tests—all installations.

See Figs. 1 and 2 for location of component parts and Fig. 7 or wiring subbase specifications for terminal locations.

## Preliminary Inspection

Perform the following inspections to avoid common problems. Make certain that:

1. Wiring connections are correct and all terminal screws are tight.
2. Flame detector(s) is clean, and installed and positioned properly. Consult the applicable instructions.
3. Correct combination of amplifier and flame detector(s) is used. See Table 2 in the Specifications section.
4. Plug-in amplifier and purge card are securely in place.
5. Burner is completely installed and ready to fire; consult equipment manufacturer instructions. Fuel lines are purged of air.
6. Combustion chamber and flues are clear of fuel and fuel vapor.
7. Power is connected to the system disconnect switch, (master switch).
8. Lockout is reset (push in reset button) only if the Relay Module is powered; see Figs. 1 and 2.
9. Run/Test Switch is in RUN position.
10. System is in the STANDBY condition. STANDBY message is viewable in the VFD.
11. All limits and interlocks are reset.

## Flame Signal Measurement (Table 9 and Fig. 25)

Measure the flame signal at the appropriate times as defined in the following Checkout tests. Read the flame signal in volts dc at the flame amplifier test jacks + and (Com) or at the Keyboard Display Module.

1. Use one megohm/volt meter with a 0 to 10 Vdc capability.
2. Set the one megohm/volt meter to the 0 to 10 Vdc range.
3. Insert the positive (red) probe into the + jack of the flame amplifier. Insert the negative (black) probe into the (Com) jack of the flame amplifier; see Fig. 25.
4. Allow a few seconds for the meter reading to stabilize.
5. If using AMPLI-CHECK™ or shutter check amplifiers, read the average stable voltage, disregarding the peaks and valleys caused by the self-checking operation.
6. The meter reading must be as specified in Table 8 after all tests are completed and all adjustments made.

As an option, the flame signal can be checked by using the Keyboard Display Module.

If the signal is unstable or less than the minimum acceptable voltage, check flame detector installation and circuitry.

1. Check the supply voltages at terminals 4 (L1) and L2 (N). Make sure the master switch is closed, connections are correct, and the power supply is of the correct voltage, frequency and is sinusoidal.
2. Check the detector wiring for defects including:
   a. Incorrect connections.
   b. Wrong type of wire.
   c. Open circuits.•Deteriorated wire.
   d. Short circuits.
   e. Leakage paths caused by moisture, soot or accumulated dirt.

**Table 9. Flame Signal.**

| Flame Detector | Flame Signal Amplifier | Minimum Acceptable Steady dc Voltage[a] | Maximum Expected dc Voltage |
|---|---|---|---|
| 817-1121 | 833-2741[b] | 1.25 Vdc | 5.0 Vdc at Keyboard Display Module<br>or<br>5.0 Vdc at one megohm/volt meter. |
| 817-1742 | 833-2722 or<br>833-2723[c] | | |
| 817-1743 | 833-2724 | | |
| 817-4133 | 833-3495 or<br>833-3496[c] | | |

[a] This minimum or stronger signal should easily be obtained if the detector is correctly installed and positioned to properly sense the flame. This voltaged must be obtained before completing checkout.

[b] The flame detector shutter and amplifier are tested one-half second every five seconds. Series 4 (or greater) amplifiers pulse the shutter when the flame signal reaches 1.5 Vdc. Expected flame signal on Series 4 (or greater) amplifiers will vary between 0.8 Vdc and 2.4 Vdc.

[c] This flame amplifier is AMPLI-CHECK™ type. The flame signal amplifier circuitry is tested 1/2 second every five seconds during burner operation and shuts down the burner if the amplifier fails.

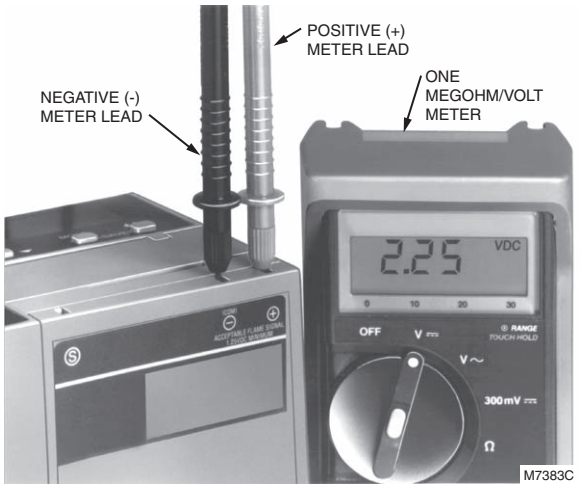



**Fig. 24. Flame signal measurement.**

3. For all optical detectors, clean the detector viewing window and inside of the sight pipe as applicable.
4. With the burner running, check temperature at the detector. If it exceeds the detector maximum rated temperature:
   a. Add a heat block to stop conducted heat traveling up the sight pipe.
   b. Add a shield or screen to reflect radiated heat.
   c. Add cooling (refer to sight pipe ventilation in the detector Instructions).
5. Make sure the flame adjustment is not too lean.
6. Make sure the detector is properly sighting the flame.
7. If necessary, resight or reposition the detector.

## Initial Lightoff Check for Proved Pilot

Perform this check on all installations that use a pilot. It should immediately follow the preliminary inspection.

NOTE: Low fuel pressure limits, if used, could be open. If so, bypass them with jumpers during this check.

1. Open the master switch.
2. Make sure that the manual main fuel shutoff valve(s) is closed. Open the manual pilot shutoff valve. If the pilot takeoff is downstream from the manual main fuel shutoff valve(s), very slightly open the manual main valve to supply pilot gas flow. Make sure the main fuel is shut off just up-stream from the burner inlet, or disconnect power from the automatic main fuel valve(s).
3. Close the master switch and start the system with a *call for heat* by raising the set point of the operating controller; see Fig. 19 or CB 780/CB 784 sequence. The program should start the ten second INITIATE sequence.
4. Let the sequence advance through PREPURGE. When the PILOT IGN status is displayed on the Keyboard Display Module, ignition spark should occur and the pilot should light. If the pilot ignites, the FLAME LED will be energized. Proceed to step 7.
5. If the pilot flame is not established in ten seconds, safety shutdown occurs. Let the sequence complete its cycle. Consult the equipment operating manual for further information.
6. Push the reset pushbutton, and let the system recycle once. If the pilot still does not ignite, make the following ignition/pilot adjustments:
   a. Open master switch and remove the CB 780/CB 784 from the subbase.
   b. On the subbase, temporarily jumper terminal 4 to ignition terminals 8, 10 or 21; refer to the appropriate wiring diagram to determine the proper terminal. Disconnect the leadwire to the pilot valve if it is connected to the same terminal.
   c. Close the master switch to energize only the ignition transformer.
   d. If the ignition spark is not strong and continuous, open the master switch and adjust the ignition electrode spark gap setting to the manufacturer recommendations.
   e. Make sure the ignition electrodes are clean.
   f. Close the master switch and observe the spark.
   g. After a continuous spark is obtained, open the master switch and add a jumper on the subbase from terminal 4 (L1) to the pilot terminal 8 or 21. Reconnect the leadwire from the pilot valve if it was disconnected in step b.
   h. Close the master switch to energize both the ignition transformer and the pilot valve.
   i. If the pilot does not ignite and if the ignition spark is still continuous, adjust the pressure regulator until a pilot is established.
   j. When the pilot ignites properly and stays ignited, open the master switch and remove the jumper(s) from terminals 4-8, 4-10 and 4-21 of the subbase.
   k. Check for adequate bleeding of the fuel line.
   l. Reinstall the CB 780/CB 784 on the subbase, close the master switch, and then return to step 4.
7. When pilot ignites, measure the flame signal. If the pilot flame signal is unsteady or approaching the 1.25 Vdc minimum value, adjust the pilot flame size or detector sighting to provide a maximum and steady flame signal.
8. Recycle the system to recheck lightoff and pilot flame signal.
9. When the MAIN IGN period is displayed on the VFD, make sure the automatic main fuel valve is open; then smoothly open the manual main fuel shutoff valve(s) and watch for main burner flame ignition. When the main burner flame is established, proceed to step 15.
10. If the main burner flame is not established within ten seconds, close the manual main fuel shutoff valve(s).
11. Recycle the system to recheck the lightoff and pilot flame signal.
12. Smoothly open the manual fuel shutoff valve(s) and try lightoff again. (The first reattempt may have been required to purge the lines and bring sufficient fuel to the burner.)
13. If the main burner flame is not established within five seconds or the normal lightoff time specified by the equipment manufacturer, close the manual main fuel shutoff valve(s). Check all burner adjustments.

14. If the main burner flame is not established after two attempts:
    a. Check for improper pilot size.
    b. Check for excess combustion air at low fire.
    c. Check for adequate low fire fuel flow.
    d. Check for proper gas supply pressure.
    e. Check for proper valve operation.
    f. Check for proper pilot flame positioning.
15. Repeat steps 10 through 14 to establish the main burner flame; then proceed to step 16.
16. With the sequence in RUN, make burner adjustments for flame stability and Btu input rating.
17. Shut down the system by opening the burner switch or by lowering the set point of the operating controller. Make sure the main flame goes out. There may be a delay due to gas trapped between the valve(s) and burner. Make sure all automatic fuel valve(s) close.
18. Restart the system by closing the burner switch and/or raising the set point of the operating controller. Observe that the pilot is established during PILOT IGN and the main burner flame is established during MAIN IGN within the normal lightoff time.
19. Measure the flame signal. Continue to check for the proper signal, see Table 9, through the RUN period. Check the signal at both High and Low Firing Rate positions and while modulating.
20. Run the burner through another sequence, observing the flame signal for:
    a. Pilot flame alone (DSI).
    b. Pilot and main flame together.
    c. Main flame alone (unless monitoring an intermittent pilot). Also observe the time it takes to light the main flame. Ignition of main flame should be smooth.
21. Make sure all readings are in the required ranges before proceeding.
22. Return the system to normal operation.

NOTE: After completing these tests, open the master switch and remove all test jumpers from the subbase terminals, limits/controls or switches.

## Initial Lightoff Check for Direct Spark Ignition

This check applies to gas and oil burners not using a pilot. It should immediately follow the preliminary inspection. Refer to the appropriate sample block diagram of field wiring for the ignition transformer and fuel valve(s) hookup.

NOTE: Low fuel pressure limits, if used, could be open. If so, bypass them with jumpers during this check.

1. Open the master switch.
2. Complete the normal *ready-to-fire* checkout of the fuel supply and equipment as recommended by the equipment manufacturer.
3. Close all manual main fuel shutoff valve(s). Check that the automatic fuel valve(s) are closed. Make sure fuel is not entering the combustion chamber.
4. Close the master switch and start the system with a *call for heat* by raising the setpoint of the operating controller, see Fig.18 for CB 780/CB 784 sequencing. The program sequence should start the ten second INITIATE sequence.
5. Let the sequence advance through PREPURGE. Ignition spark should occur after PREPURGE period. Listen for the click of the first stage fuel solenoid valve(s).
6. Let the program sequence complete its cycle.
7. Open the manual fuel shutoff valve(s).
8. Push the reset button and recycle the program sequence through PREPURGE.
9. When PILOT IGN status is displayed, watch that the first stage burner flame is established. If it is established, proceed to step 15.
10. If the first stage burner flame is not established within ten seconds, close the manual fuel shutoff valve(s), and open the master switch after POSTPURGE is completed.
11. Check all burner adjustments.
12. Wait about three minutes. Close the master switch, open the manual fuel shutoff valve(s), and try to lightoff the burner again. The first attempt may have been required to purge the lines and bring sufficient fuel to the burner.
13. If the first stage burner flame is not established within ten seconds, close the manual fuel shutoff valve(s), and open the master switch.
14. If necessary, repeat steps 11 through 13 to establish the first stage burner flame. Then proceed to step 15.
15. When the first stage burner flame is established, the sequence will advance to RUN. Make burner adjustments for flame stability and input rating. If a second stage is used, proceed to step 18.
16. Shut down the system by opening the burner switch or by lowering the set point of the operating controller. Make sure the burner flame goes out and all automatic fuel valve(s) close.
17. If used, remove the bypass jumpers from the low fuel pressure limit and subbase.
18. If a second stage is used, make sure the automatic second stage fuel valve(s) has opened. Check the lightoff as follows (otherwise proceed to step 19):
    a. Open the manual second stage fuel valve(s).
    b. Restart the system by raising the set point of the operating controller.
    c. When the first stage burner flame is established, watch for the automatic second stage fuel valve(s) to open. Observe that the second stage lights off properly.
    d. Make burner adjustments for flame stability and input rating.
    e. Shut down the system by lowering the set point of the operating controller. Make sure the burner flame goes out and all automatic fuel valve(s) close.
    f. Proceed to step 19.
19. Restart the system by closing the burner switch and/or raising the set point of the operating controller. Observe that the burner flame is established during PILOT IGN, within the normal lightoff time specified by the equipment manufacturer.
20. Measure the flame signal. Continue to check for the proper signal, see Table 9, through the RUN period. Check the signal at both high and low firing rate positions and while modulating. Any pulsating or unsteady readings will require further attention.
21. Make sure all readings are in the required ranges before proceeding.

NOTE: Upon completing these tests, open the master switch and remove all test jumpers from the subbase terminals, limits/controls or switches.

**22.** Return the system to normal operation.

## Pilot Turndown Test (All Installations Using a Pilot)

Perform this check on all installations that use a pilot. The purpose of this test is to verify that the main burner can be lit by the smallest pilot flame that will hold in the flame amplifier and energize the FLAME LED. Clean the flame detector(s) to make sure that it will detect the smallest acceptable pilot flame. If using AMPLI-CHECK™ or Self-Checking Amplifier and 1M ohm/volt meter, the flame signal will fluctuate every time the amplifier does a self-check or a shutter check.

NOTE: Low fuel pressure limits, if used, could be open. If so, bypass them with jumpers during this test.

1. Open the master switch.
2. Close the manual main fuel shutoff valve(s).
3. Connect a manometer (or pressure gauge) to measure pilot gas pressure during the turndown test.
4. Open the manual pilot shutoff valve(s).
5. Close the master switch and start the system with a *call for heat.* Raise the set point of the operating controller. The program sequence should start, and PREPURGE should begin.
6. When the PILOT IGN begins, set the Run/Test Switch to TEST position to stop the sequence. The FLAME LED will come on when the pilot ignites.

NOTE: If the sequence does not stop, reset the system and make sure you set the Run/Test Switch to TEST within the first eight seconds of the PILOT IGN sequence.

***IMPORTANT:***

*You have eight seconds or three seconds, depending on PFEP selected, to position the Run/Test Switch to the TEST position to stop the sequence after the start of the PILOT IGN period.*

7. Turn the pilot pressure down very slowly, reading the manometer (or pressure gauge) as it drops. Stop instantly when the FLAME LED goes out. Note the pressure at the CB780/CB784 flame relay dropout point. The pilot is at the minimum turndown position. Immediately turn up the pilot pressure until the FLAME LED comes on again or the flame signal increases to 1.25 Vdc.

NOTE: If there is no flame for fifteen seconds with the sequence stopped at this point, the CB780/CB784 will lockout and flash a lockout message; see Fig. 26.

8. Repeat step 7 to verify the pilot gas pressure reading at the exact point the FLAME LED light goes out.
9. Increase the pilot pressure immediately until the FLAME LED comes on, and then turn it down slowly to obtain a pressure reading just above the dropout point or until the flame signal increases to 1.25 Vdc.
10. Set the Run/Test Switch in the RUN position and let the sequence proceed. At ten seconds into the Ignition Trial period, make sure the automatic main fuel valve(s) open; then smoothly open the manual main fuel shutoff valve(s) (or any other manually opened safety shutoff valve(s), if used) and watch for main burner ignition. If the main burner flame is established, proceed to step 18.

NOTE: This step requires two people, one to open the manual valve(s) and one to watch for ignition.

11. If the main burner flame is not established within ten seconds, close the manual main fuel shutoff valve(s) and open the master switch. If the lightoff was rough, the pilot flame size is too small.
12. Recycle the burner and stop the sequence in the PILOT IGN period by using the Run/Test Switch.
13. Increase the pilot flame size by increasing its fuel flow until a smooth main flame is accomplished.
14. Reposition the flame scanner sight tube or use orifices until the pilot flame signal voltage is in the range of 1.25 to 1.50 Vdc.
15. When the main burner lights reliably with the pilot at turndown, disconnect the manometer (or pressure gauge) and turn the pilot gas flow up to that recommended by the equipment manufacturer.
16. If used, remove the bypass jumpers from the subbase terminals, limits/controls, or switches.
17. Run the system through another cycle to check for normal operation.
18. Return the system to normal operation.

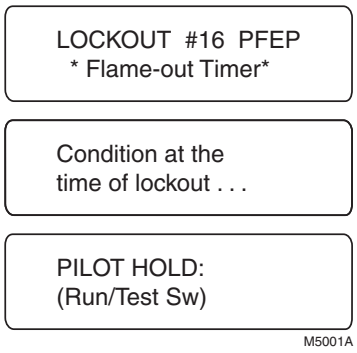



**Fig. 25. Flame-out timer lockout.**

## Hot Refractory Saturation Test (All Infrared Detectors)

Test to make certain that radiation from hot refractory does not mask the flickering radiation of the flame itself.

Start the burner and monitor the flame signal during the warm-up period. A decrease in signal strength as the refractory heats up indicates hot refractory saturation. If saturation is extreme, the flame signal will drop below 1.25 Vdc and the system will shut down as though a flame failure occurred.

If hot refractory saturation occurs, the condition must be corrected. Add an orifice plate in front of the cell to restrict the viewing area, lengthen the sight pipe or decrease the pipe size (diameter). Continue adjustments until hot refractory saturation is eliminated.

## Hot Refractory Hold-in Test (All Infrared Detectors)

Test to make certain hot refractory will not delay the flame detection system response to a flameout. This condition can delay response to flame failure and also can prevent a system restart as long as hot refractory is detected.

Infrared (lead sulfide) detectors can respond to infrared rays emitted by a hot refractory, even when the refractory has visibly ceased to glow. Infrared radiation from a hot refractory is steady, but radiation from a flame has a flickering characteristic. The infrared detection system responds only to flickering infrared radiation; it can reject a steady signal from hot refractory. The refractory steady signal can be made to fluctuate if it is reflected, bent or blocked by smoke or fuel mist within the combustion chamber. Be careful when applying an infrared system to verify its response to flame only.

To check infrared (lead sulfide) detectors for hot refractory hold-in, operate the burner until the refractory reaches its maximum temperature. If the installation has a multi-fuel burner, burn the heavier fuel that is most likely to reflect, bend or obscure the hot refractory steady infrared radiation. When the maximum refractory temperature is reached, close all manual fuel shutoff valve(s), or open the electrical circuits of all automatic fuel valve(s). Visually observe when the burner flame or FLAME LED goes out. If this takes more than three seconds, the infrared detector is sensing hot refractory. Immediately terminate the firing cycle. (Lower the set point to the operating controller, or set the Burner Switch to OFF. Do not open the master switch.)

NOTE: Some burners continue to purge oil lines between the valve(s) and nozzle(s) even though the fuel valve(s) are closed. Terminating the firing cycle (instead of opening the master switch) will allow purging the combustion chamber. This will reduce a buildup of fuel vapors in the combustion chamber caused by oil line purging.

If the detector is sensing hot refractory, the condition must be corrected. Add an orifice plate in front of the cell to restrict the viewing area of the detector. If this does not correct the problem, resight the detector at a cooler, more distant part of the combustion chamber. While resighting the detector, be aware that it must also properly sight the flame. For an infrared detector, try lengthening the sight pipe or decreasing the pipe size (diameter). For details, refer to the detector Instructions and the equipment Operating Manual. Continue adjustments until hot refractory hold-in is eliminated.

## Ultraviolet Sensor, Ignition Spark Response Test (All Ultraviolet Detectors)

Test to make certain that the ignition spark is not actuating the FLAME LED.

1. Close the pilot and main burner manual fuel shut-off valve(s).
2. Start the burner and use the Run/Test Switch to stop the sequence in the PILOT IGN period. Ignition spark should occur, but the flame signal should not be more than 0.5 Vdc.
3. If the flame signal is higher than 0.5 Vdc and the FLAME LED does come on, consult the equipment operating manual and resight the detector farther out from the spark, or away from possible reflection. It may be necessary to construct a barrier to block the ignition spark from the detector view. Continue adjustments until the flame signal due to ignition spark is less than 0.5 Vdc.

## Response to Other Ultraviolet Sources

Some sources of artificial light, such as incandescent or fluorescent bulbs, mercury sodium vapor lamps and daylight, produce small amounts of ultraviolet radiation. Under certain conditions, an ultraviolet detector will respond to these sources as if it is sensing a flame. To check for proper detector operation, check the Flame Failure Response Time (FFRT) and conduct Safety Shutdown Tests under all operating conditions.

## Flame Signal With Hot Combustion Chamber (All Installations)

With all initial start-up tests and burner adjustments completed, operate the burner until the combustion chamber is at the maximum expected temperature. Observe the equipment manufacturer warm-up instructions. Recycle the burner under these hot conditions and measure the flame signal. Check the pilot alone, the main burner flame alone, and both together (unless monitoring only the main burner flame when using DSI). Check the signal at both High and Low Firing Rate positions and while modulating, if applicable.

If the flame signal is too low or unsteady, check the flame detector temperature. Relocate the detector if the temperature is too high. If necessary, realign the sighting to obtain the proper signal and response time. If the response time is still too slow, replace the Plug-in Flame Signal Amplifier. If the detector is relocated or resighted, or the amplifier is replaced, repeat all required Checkout tests.Check the FFRT of the Flame Amplifier. Lower the set point of the operating controller and observe the time it takes for the burner flame to go out. This should be within 3 seconds maximum.

## Safety Shutdown Tests (All Installations)

Perform these tests at the end of Checkout, after all other tests have been completed. If used, the external alarm should turn on. Press the CB780/CB784 reset pushbutton to restart the system.

1. Opening a Preignition Interlock during STANDBY or PREPURGE period.
   a. *Preignition ILK* fault will be displayed on the VFD. Fault code 10 or 33 will be displayed to denote the fault.
   b. Safety shutdown will occur.
2. Opening a Lockout Interlock during PREPURGE, PILOT IGN, MAIN IGN or RUN period.
   a. *Lockout ILK* fault will be displayed on the VFD. Fault code 11 or 12 or 21 or 29 will be displayed to denote the fault.
   b. Safety shutdown will occur.
3. Detection of flame 40 seconds after entry to STANDBY, fault code 9. Detection of flame ten seconds into Drive to Purge Rate or during measured PREPURGE time.
   a. Simulate a flame to cause the flame signal voltage level to be at least 1.25 Vdc for 40 seconds after entry to STANDBY and also simulate a flame signal for 10 seconds during PREPURGE.
   b. *Flame Detected* fault will be displayed on the VFD. Fault code 9 or 15 or 18 will be displayed to denote the fault.
   c. Safety shutdown will occur.
4. Failure to ignite pilot.
   a. Close pilot and main fuel manual shutoff valve(s).
   b. Depress the reset button.
   c. Start the system.
   d. The automatic pilot valve(s) should be energized but the pilot cannot ignite.
   e. *Pilot Flame Fail* fault will be displayed on the VFD. Fault code 28 will be displayed four or ten seconds (depending on the jumper configuration selection for PFEP) after the pilot valve(s) is energized to denote the fault.
   f. Safety shutdown will occur.
5. Failure to ignite main.
   a. Open the manual pilot valve(s); leave the main fuel manual shutoff valve(s) closed.
   b. Depress the reset button.
   c. Start the system.
   d. The pilot should ignite and the flame signal should be at least 1.25 Vdc but the main burner cannot light.
   e. The flame signal should drop below 1.25 Vdc within 3 seconds after the interrupted pilot goes out.
   f. *Main Flame Ign.* fault will be displayed on the VFD. Fault code 19 will be displayed to denote the fault.
   g. Safety shutdown will occur.
6. Loss of flame during RUN.
   a. Open the main fuel manual shutoff valve(s) and open manual pilot shutoff valve(s).
   b. Depress the reset button.
   c. Start the system. Start-up should be normal and the main burner should light normally.
   d. After the sequence is in the normal RUN period for at least ten seconds with the main burner firing, close the manual main fuel shutoff valve(s) to extinguish the main burner flame.
   e. The flame signal should drop below 1.25 Vdc within 3 seconds after the main flame goes out.
   f. *Main Flame Fail* fault will be displayed on the KDM. Fault code 17 will be displayed to denote the fault.
   g. Safety shutdown will occur.
7. Opening a Preignition Interlock after the first five seconds of POSTPURGE.
   a. *Preignition ILK* fault will be displayed on the KDM. Fault code 33 will be displayed to denote the fault.
   b. Safety shutdown will occur.

***IMPORTANT:***

1. *If the CB780/CB784 fails to shut down on any of these tests, take corrective action; refer to CB780/CB784 Troubleshooting and diagnostics manual and return to the beginning of all Checkout tests.*
2. *When all Checkout tests have been completed, reset all switches to original status.*

# TROUBLESHOOTING

## CB780/CB784 System Diagnostics

Troubleshooting control system equipment failures is made easier with the CB780/CB784 self-diagnostics and first-out annunciation. In addition to an isolated spst alarm relay (audible annunciation), the CB780/CB784 provides visual annunciation by displaying a fault code and fault or hold message at the Keyboard Display Module. The CB780/CB784 provides118 diagnostic messages for troubleshooting the system (see the CB780/CB784 System Annunciation Diagnostics and Troubleshooting, Bulletin Number CB-7803.

Self-diagnostics of the CB780/CB784 enables it to detect and annunciate both external and internal system problems. Internal faults and external faults such as interlock failures, flame failures and false flame signals are annunciated by the CB780/CB784, which energizes the ALARM LED or visually displayed at the Keyboard Display Module.

The KDM displays a sequence status message indicating: STANDBY, PREPURGE, PILOT IGN, MAIN IGN, RUN and POSTPURGE. The selectable messages also provide visual indication of current status and historical status of the equipment such as: Flame Signal, Total Cycles, Total Hours, Fault History, Diagnostic Information and Expanded Annunciator terminal status (if used). With this information, most problems can be diagnosed without extensive trial and error testing.

Table 4 provides the sequence and status hold messages. Table 10 provides a summary of all CB780/CB784 fault messages and fault codes. In addition, Diagnostic Information and History Data are available to assist in troubleshooting the CB780/CB784, see Table 6.

The CB780/CB784 provides diagnostic information to aid the service mechanic in obtaining information when troubleshooting the system, see Tables 4, 5, 6 and 10. Information available in the Diagnostic Information includes Device Type, Device Suffix, Software Revision, Manufacturing Code, Flame Amplifier Type, Flame Failure Response Time, Selectable Jumper Configuration Status, Run/Test Switch Status and Terminal Status.

## Diagnostic Information Index

The CB780/CB784 monitors input/output terminals and can display the status of the terminal at the KDM (example: Pilot Valve T8 ON<). See Table 5 for a complete terminal description and number. The display will show the actual status of the terminal. If voltage is detected at the terminal, ON is displayed, but if no voltage is detected at the terminal, OFF is displayed; see Table 5.

## Historical Information Index

The CB780/CB784 has nonvolitile memory that allows the Relay Module to retain Historical Information for the six most recent lockouts. Each of the six lockout files retains the cycle when the fault occurred, the hour of operation when the fault occurred, a fault code, a fault message and burner status when the fault occurred; see Table 4.

**SERVICE NOTE:**
Reset CB780/CB784 by pressing the reset pushbutton on the CB780/CB784, or pressing a remote reset push-button wired through the the 5-wire connector (833-2760, ordered separately) on the Keyboard Display Module or DATA CONTROLBUS MODULE™. A power-up reset will cause an electrical reset of the CB780/CB784 but will not reset a lockout condition.

**SERVICE NOTE:**
If the Keyboard Display Module is *scrambled*, remove and reinstall the Keyboard Display Module, and reset the CB780/CB784 Relay Module.

**SERVICE NOTE:**
Use the access slots on the sides of the Wiring Subbase to check the terminal voltage of the CB780/CB784.

**SERVICE NOTE:**
Maximum ambient operating temperature of an 817-1121 flame sensor, Series 1 through 6 will be reduced to 125°F because of the duty cycle operation of the CB780/CB784 Relay Module.

**Table 10. Hold and Fault Message Summary.**

| Fault Number | Annunciation Message |
|---|---|
| Fault 1 | *No Purge Card* |
| Fault 2 | *AC Frequen/Noise* |
| Fault 3 | *AC Line Dropout* |
| Fault 4 | *AC Frequency* |
| Fault 5 | *Low Line Voltage* |
| Fault 6 | *Purge Card Error* |
| Fault 7 | *Flame Amplifier* |
| Fault 8 | *Flame Amp/Shutr* |
| Fault 9 | *Flame Detected* |
| Fault 10 | *Preignition ILK* |
| Fault 11 | *Running ILK On* |
| Fault 12 | *Lockout ILK On* |
| Fault 14 | *High Fire Sw.* |
| Fault 15 | *Flame Detected* |
| Fault 16 | *Flame-Out TImer* |
| Fault 17 | *Main Flame Fail* |
| Fault 18 | *Flame Detected* |
| Fault 19 | *Main Flame Ign.* |
| Fault 20 | *Low FIre Sw. Off* |
| Fault 21 | *Running ILK* |
| Fault 24 | *Call Service* |
| Fault 25 | *Call Service* |
| Fault 28 | *Pilot Flame Fail* |
| Fault 29 | *Lockout ILK* |
| Fault 33 | *Preignition ILK* |
| Fault 35-40 | *Call Service* |
| Fault 41 | *Main Valve On* |
| Fault 42 | *Pilot Valve On* |
| Fault 43 | *Ignition On* |
| Fault 44 | *PIlot Valve 2 On* |
| Falt 45 | *Low Fire Sw. Off* |
| Falut 46 | *Flame Amp. Type* |
| Fault 47 | *Jumpers Changed* |
| Fault 50 | *Jumpers Wrong* |
| Fault 51 | *Flame Too Strong* |

**Table 10. Hold and Fault Message Summary. (Continued)**

| Fault Number | Annunciation Message |
|---|---|
| Fault 52-70 | *Call Service* |
| Fault 71-75 | *Device Specific* |
| Fault 76-93 | *Accessory Fault* |
| Fault 94-127 | *Call Service* |

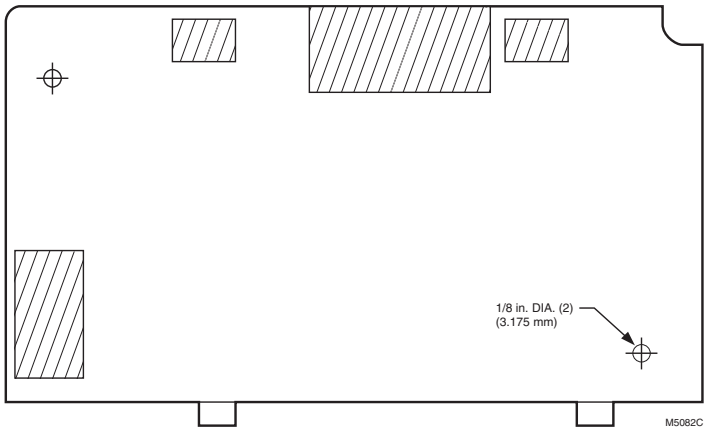



**Fig. 26. Flush mounting of a Keyboard Display Module template.**

# SAFETY AND SECURITY

## Physical device protection

Device shall be accessible to authorized personnel only – Installation on publicly accessible places is not recommended as this could lead to unwanted and potentially unsafe changes to device (wiring, configuration, etc).

It is recommended to lock the device in an enclosed cabinet with access allowed only to approved and trained personnel. Also, it is strongly advised to keep all the wiring of device physically secure.

Physical protection of the device is applied via Run/Test switch label/seal. It is intended to prevent and detect unauthorized access.

## Modbus & DDL Interface security

Any conducts critical to device functionality (DDL, Modbus lines etc.) shall be physically protected (installed outside public access) since they could be damaged or tampered-with by unauthorized people, either accidentally or for purpose.

Modbus RS-485 & DDL protocols do not support security features. For DDL interface - only DDL devices shall be connected to the Burner Controller DDL line.

## License agreement

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