

R4780 Protectorelay User's Manual



Thank you for purchasing the R4780 Protectorelay.

This manual contains information for ensuring the correct use of the R4780. It also provides necessary information for installation, maintenance, and troubleshooting.

This manual should be read by those who design and maintain equipment that uses the R4780. Be sure to keep this manual nearby for handy reference.

Yamatake Corporation

RESTRICTIONS ON USE

This product has been designed, developed and manufactured for general-purpose application in machinery and equipment.

Accordingly, when used in applications outlined below, special care should be taken to implement a fail-safe and/or redundant design concept as well as a periodic maintenance program.

- Safety devices for plant worker protection
- Start/stop control devices for transportation and material handling machines
- Aeronautical/aerospace machines
- Control devices for nuclear reactors

Never use this product in applications where human safety may be put at risk.

NOTICE

Be sure that the user receives this manual before the product is used.

Copying or duplicating this user's manual in part or in whole is forbidden. The information and specifications in this manual are subject to change without notice.

Considerable effort has been made to ensure that this manual is free from inaccuracies and omissions. If you should find an error or omission, please contact Yamatake Corporation.

In no event is Yamatake Corporation liable to anyone for any indirect, special or consequential damages as a result of using this product.

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SAFETY PRECAUTIONS

■ About Icons

The safety precautions described in this manual are indicated by various icons. Please be sure you read and understand the icons and their meanings described below before reading the rest of the manual.

Safety precautions are intended to ensure the safe and correct use of this product, to prevent injury to the operator and others, and to prevent damage to property. Be sure to observe these safety precautions.



WARNING

Warnings are indicated when mishandling this product might result in death or serious injury.



CAUTION

Cautions are indicated when mishandling this product might result in minor injury to the user, or only physical damage to the product.

■ Examples

	Use caution when handling the product.
	The indicated action is prohibited.
	Be sure to follow the indicated instructions.

WARNING



Use this device for batch operation of the burner (at least one start and stop in a 24-hour period). Even if the batch operation, for improving the safety of high-intensity combustion and important equipment, use a protectorelay with a continuous self-check function that checks the flame detector and the flame detection circuit continuously.



Before wiring, mounting, or removing this device, be sure to turn the power off. Wiring with the power on can result in an electric shock.



Do not connect a solenoid valve to the hot side of the circuit. If a ground fault occurs, the ground fault current may energize and open the solenoid valve. This device will not be able to prevent the valve from opening and fuel from flowing out.



Do not touch the terminals during trial-run adjustments. Doing so might cause an electric shock.



Before the pilot turndown test or ignition spark response test, make sure that all manual fuel valves are closed.



If the pilot turndown test must be carried out repeatedly, completely shut down all equipment each time the test is finished, and completely discharge unburned gas or fuel that has accumulated in the ducts and combustion chamber. Failure to discharge unburned gas or fuel may result in an explosion.



When the pilot turndown test is complete, turn OFF the power switch to shut down the power. Restore all test jumpers and limit interlock/regulator settings to their previous states. If operation begins without the above steps, damage to the equipment, gas leak or explosion may result.



Do not start regular operation of the equipment without first completing the trial-run adjustments for this device, as well as the tests specified by the equipment manufacturer.



Do not touch the terminals during the power is charged. Doing so might cause an electric shock.



Even after the power to this device is turned off, terminal F continues to hold an electrical charge. To avoid electrical shock, do not touch terminal F.



When the safety switch operates or the lockout occurs, reset after removing the causes. However do not reset repeatedly. Doing so might cause a serious accident of the combustion equipment.

CAUTION



This device is equipped with functions that are extremely important for the safe operation of combustion equipment. Carefully follow the instructions for its use that are given in this user's manual, combined equipment's user's manual and combustion equipment's user's manual. And, contact Yamatake salesperson when planning the system of flame safe guard control.



Do not install where exposed to any of the following:

- Certain chemicals or corrosive gases (ammonia, sulfur, chlorine, ethylene compounds, acid, etc.).
- Splashing water or excessive humidity.
- High temperatures.
- Prolonged vibration.



Installation, wiring, inspection, adjustment, etc. should be carried out by a trained and experienced technician who has knowledge and technical skills related to combustion equipment and flame safeguard control devices.



When installing and wiring, be sure to follow the instructions in this manual and in the user's manual for the combustion equipment.



Follow all applicable regulations when doing the wiring work.



Do not connect the load exceeding the rating provided by specifications.



Make sure that ignition transformer high-voltage cables are properly connected to prevent faulty contact. Faulty contact might generate high-frequency radio waves which can cause malfunction.



The ignition transformer ground lead should be connected directly to the burner body or to a metallic part electrically connected to the burner body.



Always supply electric power at the voltage and frequency stated on the model label of this device.



Always connect the power supply last. Otherwise, touching a terminal accidentally could result in electric shock or damage.



After the wiring is complete, be sure to check that it is correct. Incorrect wiring may cause damage or faulty operation.



In keeping with technical standards for electrical equipment, the burner body must have an earth ground connection with a resistance of less than 100 Ω .

CAUTION



Only an experienced technician who has knowledge and technical skills related to combustion equipment and combustion safety should carry out the pilot turndown test.



If the safety shutoff has been activated, check all of the items on the checklists in chapter 4, TRIAL-RUN ADJUSTMENT before restarting the equipment.



Do not disassemble the device. Doing so might cause faulty operation or electric shock.

Contents

SAFETY PRECAUTIONS Conventions Used in This Manual

Chapter 1. OVERVIEW

■ Summary.....	1
■ Model number table.....	2
■ Accessories.....	2
■ Optional parts.....	2
■ Parts and names.....	3

Chapter 2. MOUNTING AND WIRING

■ Installation place.....	5
■ Mounting the subbase.....	5
■ Installing the protectorelay.....	5
■ Removing the protectorelay from the subbase.....	6
■ Combination high fire interlock and low fire interlock.....	6
■ Wiring diagrams.....	6
■ Wiring to a solenoid valve.....	9
■ When replacing the R8150B/C with R4780B/C.....	10

Chapter 3. OPERATIONS

■ Example of wiring to external equipment, and internal block diagram..	11
■ Normal operation.....	12
■ Sequence example.....	13

Chapter 4. TRIAL RUN AND ADJUSTMENT

■ Preliminary check.....	21
■ Test procedures.....	22

Chapter 5. MAINTENANCE AND INSPECTION




■ General items.....	25
■ Maintenance and inspection intervals.....	25
■ Troubleshooting procedure.....	26

Chapter 6. SPECIFICATIONS

■ Specifications.....	29
■ External dimensions.....	31

Conventions Used in This Manual

The following conventions are used in this manual:

-  **Handling Precautions:** Handling Precautions indicate items that the user should pay attention to when handling the R4780.
-  **Note:** Notes indicate information that might benefit the user.
- : This indicates the item or page that the user is requested to refer to.
- (1), (2), (3): Numbers within parentheses indicate steps in a sequence or parts of an explanation.

Chapter 1. OVERVIEW

■ Summary

The R4780 Protectorelay is a programmable flame safeguard controller for batch operation of oil-fired, gas-fired, or oil/gas-fired burners with a combustion capacity of 350 kW or more. Noteworthy features include the following:

- The progress of the control sequence is displayed on the status indicator.
- A ground fault detection circuit is built in to ensure safety if there is a ground fault involving the valve, ignition transformer, etc.*
- Safe operation is ensured by a pilot-only proving period, even if the flame detector has detected an ignition spark.
- The safe start circuit prevents startup if an external circuit fails or if there is a false flame signal.
- If a lockout occurs, the combustion equipment cannot be restarted unless the reset button is pushed manually.
- Both three-position control and proportional control of combustion are available.

* If deteriorated insulation or the like causes a ground fault in a load such as the ignition transformer, pilot valve, or main valve, the R4780 detects the problem and shuts down and locks out the combustion equipment even if the power does not have hot and ground sides.

■ Model number table

Model number	Rated power supply	Compatible flame detector
R4780B1003-1	100Vac, 50/60Hz	Flame rod C7007A, C7008A
R4780B1011-1	200Vac, 50/60Hz	Ultraviolet sensor C7012A
R4780C1001-2	100Vac, 50/60Hz	Ultraviolet sensor C7027A, C7035A
R4780C1019-2	200Vac, 50/60Hz	
R4780D1009-1	100Vac, 50/60Hz	CdS sensor C554A, CN120A, CN700A(discontinued model)
R4780D1017-1	200Vac, 50/60Hz	
R4780F101-2	100Vac, 50/60Hz	Contact input, FRS100B104/204* and flame rod or C7012A. FRS100C104/204* and C7035A,C7027A
R4780F119-2	200Vac, 50/60Hz	

*: Flame response of the FRS100 must be 2s or less.

■ Accessories

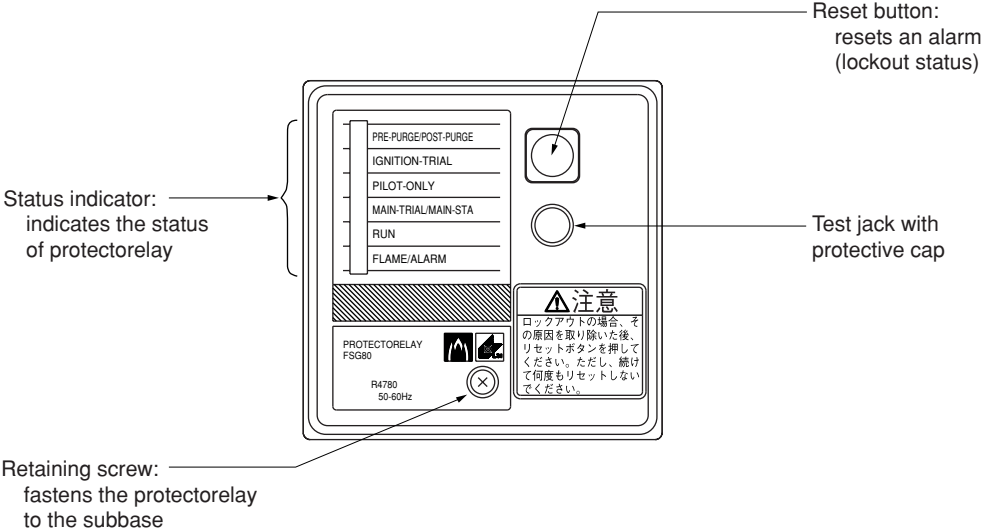
Name	Model number
Subbase	Q241A100
Surge absorber	83968019-102 (for R4780B) 83968019-001 (for R4780C/D/F)

■ Optional parts

Name	Model number
Flame simulator	123514A (for R4780B)
	123514B (for R4780C)
Analog flame meter	FSP136A100

■ Parts and names

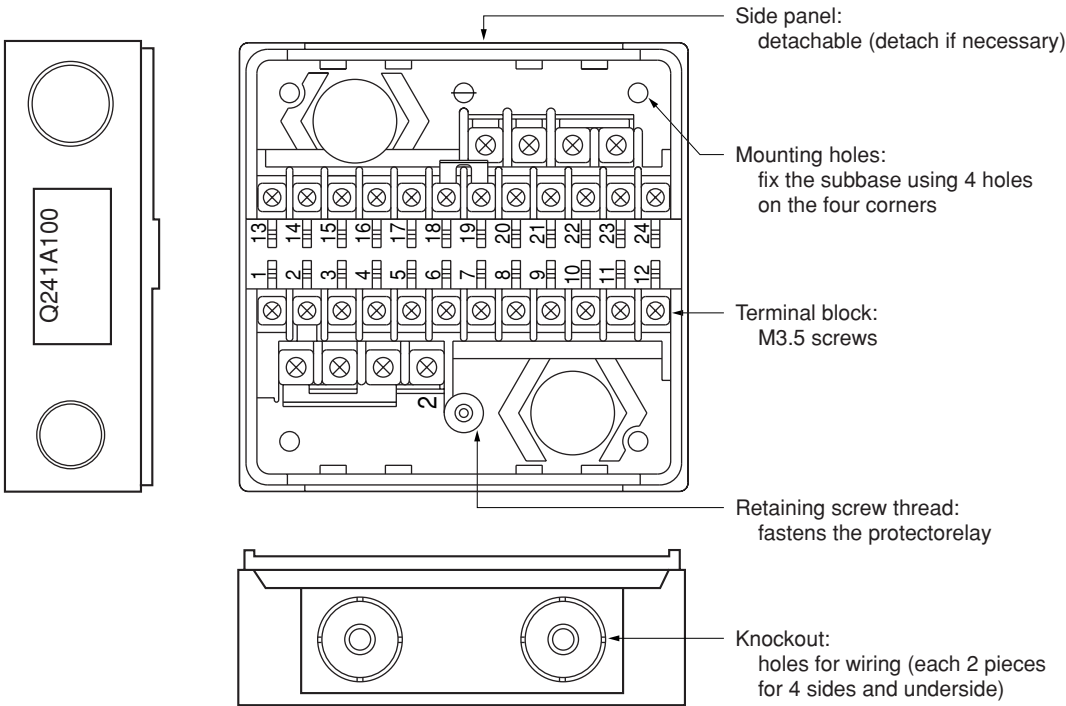
● Protectorelay



LED display details

Name	Description
PRE-PURGE/POST-PURGE	ON during pre-purge and post-purge
IGNITION-TRIAL	ON during ignition trial (Safety Time)
PILOT-ONLY	ON during pilot stabilization
MAIN-TRIAL/MAIN-STA	ON during main trial and main stabilization
RUN	ON during normal operation
FLAME/ALARM	ON during the flame is detected and blink when the alarm occurs

● Subbase



Chapter 2. MOUNTING AND WIRING

WARNING



Before wiring, mounting, or removing this device, be sure to turn the power off. Wiring with the power on can result in an electric shock.



Do not connect a solenoid valve to the hot side of the circuit. If a ground fault occurs, the ground fault current may energize and open the solenoid valve. This device will not be able to prevent the valve from opening and fuel from flowing out.

CAUTION



Installation, wiring, inspection, adjustment, etc. should be carried out by a trained and experienced technician who has knowledge and technical skills related to combustion equipment and flame safeguard control devices.



Do not install where exposed to any of the following:

- Certain chemicals or corrosive gases (ammonia, sulfur, chlorine, ethylene compounds, acid, etc.).
- Splashing water or excessive humidity.
- High temperatures.
- Prolonged vibration.



Always supply electric power at the voltage and frequency stated on the model label of this device.



In keeping with technical standards for electrical equipment, the burner body must have an earth ground connection with a resistance of less than 100 Ω .



Make sure that ignition transformer high-voltage cables are properly connected to prevent faulty contact. Faulty contact might generate high-frequency radio waves which can cause malfunction.



The ignition transformer ground lead should be connected directly to the burner body or to a metallic part electrically connected to the burner body.



After the wiring is complete, be sure to check that it is correct. Incorrect wiring may cause damage or faulty operation.

■ Installation place

⚠ CAUTION



Do not install where exposed to any of the following:

- Certain chemicals or corrosive gases (ammonia, sulfur, chlorine, ethylene compounds, acid, etc.).
- Splashing water or excessive humidity.
- High temperatures.
- Prolonged vibration.



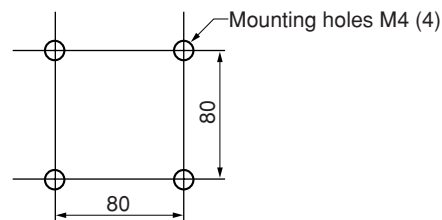
When installing and wiring, be sure to follow the instructions in this manual and in the user's manual for the combustion equipment.

The standard way of mounting the R4780 is with the display surface vertical.

■ Mounting the subbase

Mount the subbase in a vertical plane, positioned so that when the Protectorelay is mounted on the subbase, its retaining screw will be near the lower edge.

- (1) As necessary for wiring, open knockouts on the subbase.
- (2) Attach conduits to the open knockout holes.
- (3) Install the subbase in the desired position with M4 screws.



Unit: mm

Mounting dimension

⚠ Handling Precautions

- There are 5 mounting holes on the subbase, but use the 4 mounting holes indicated on the mounting dimensions diagram.
- Do not tighten screws with a force exceeding 1.5 N·m.

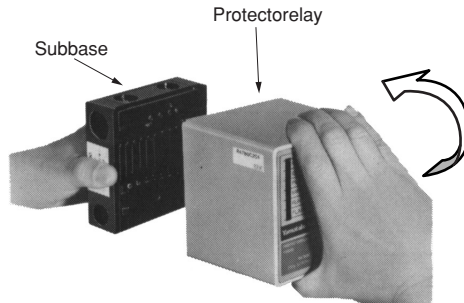
- (4) Connect according to the wiring diagram.

■ Installing the protectorelay

- (1) Position the Protectorelay so that the retaining screw is near the lower edge. Hook its upper claw onto the subbase and then push the Protectorelay onto the subbase.
- (2) Tighten the retaining screw connecting the Protectorelay to the subbase. Maximum tighten torque is 0.5 N·m.

■ Removing the Protectorelay from the subbase

Grasp the subbase firmly and pull the Protectorelay out, rotating in the direction of the arrow shown in the diagram.



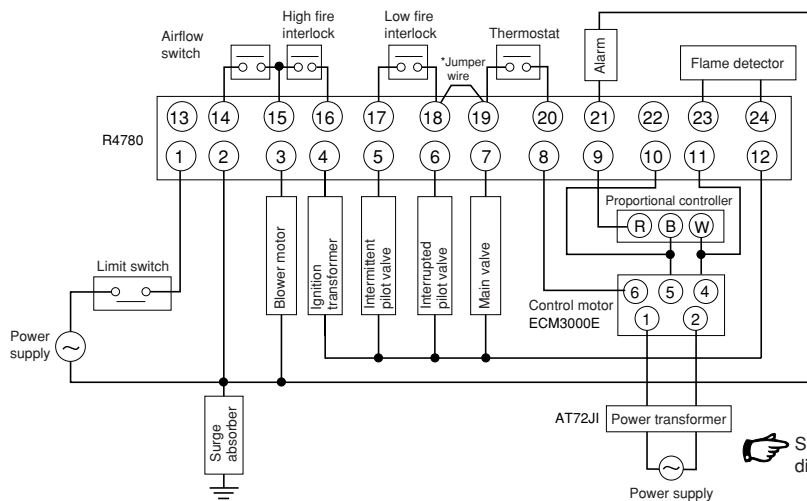
■ Combination high fire interlock and low fire interlock

Prepurge method \ Terminals:	17-18	15-16	13-17	Description
Low-high-low proving prepurge	Low fire interlock	High fire interlock	Open	Uses both high and low fire interlock
Low-high prepurge	Low fire interlock	Low fire interlock (N.O.)*	Open	Uses low fire interlock only.
Prepurge	Open	Connected with jumper	Connected with jumper	Does not use either high or low fire interlock.

*N.O.: Normally open

■ Wiring diagrams

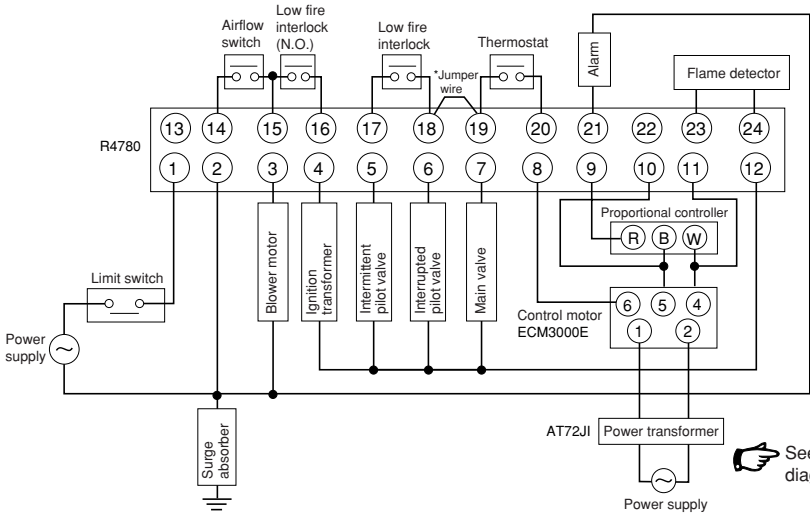
- Low-high-low proving prepurge: typical directions (when using high fire interlock and low fire interlock).



* Jumper wire is attached to the subbase.

See page 11 for a block diagram of the R4780.

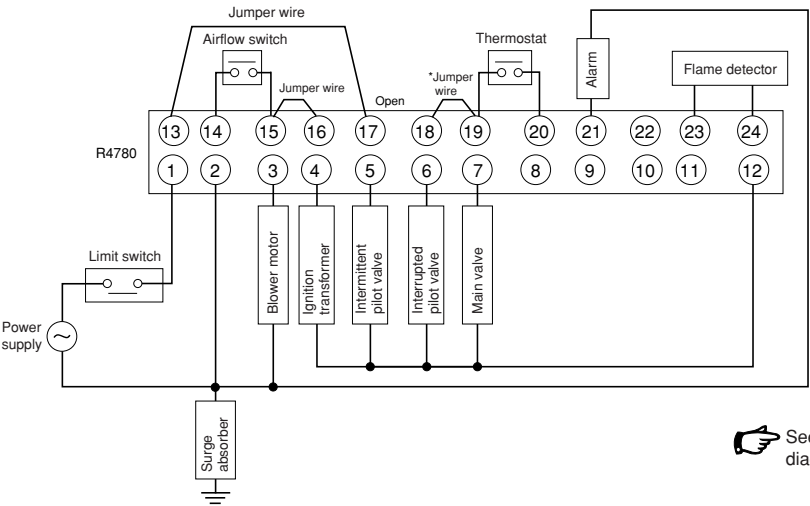
● Low-high prepurge (when using a low fire interlock only)



* Jumper wire is attached to the subbase.

See page 11 for a block diagram of the R4780.

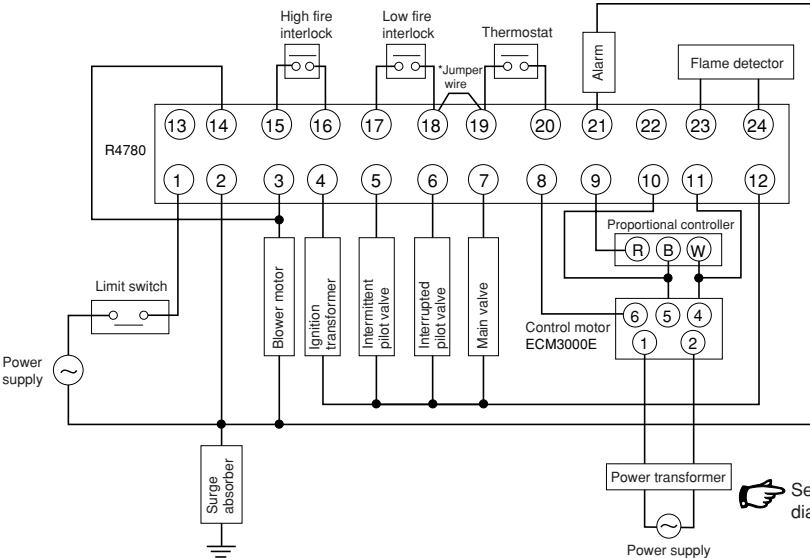
● When not using either high or low fire interlock



* Jumper wire is attached to the subbase.

See page 11 for a block diagram of the R4780.

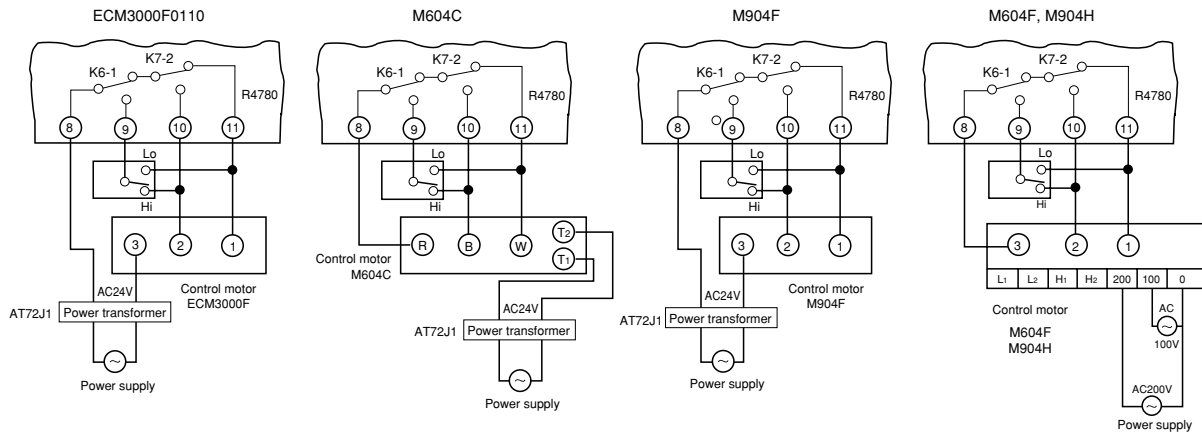
● When the airflow switch input is checked with external instrumentation and it is not connected to the R4780



* Jumper wire is attached to the subbase.

See page 11 for a block diagram of the R4780.

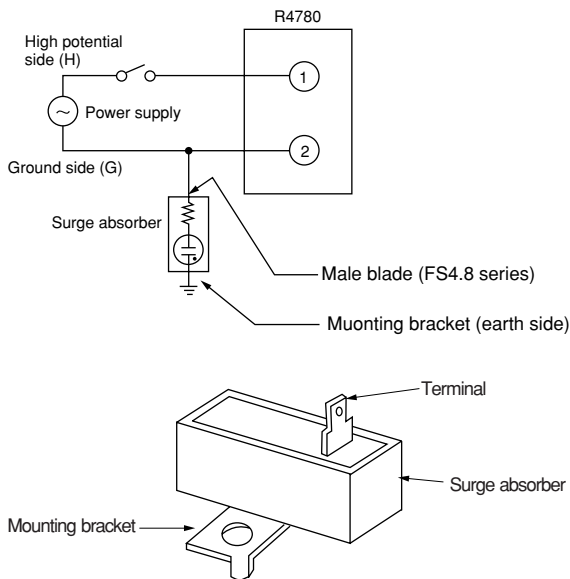
● Connection to other control motors



● Connection to a surge absorber

When using a surge absorber to prevent surges from lightning, connect as shown below.

Model numbers: 83968019-001
83968019-002



! Handling Precautions

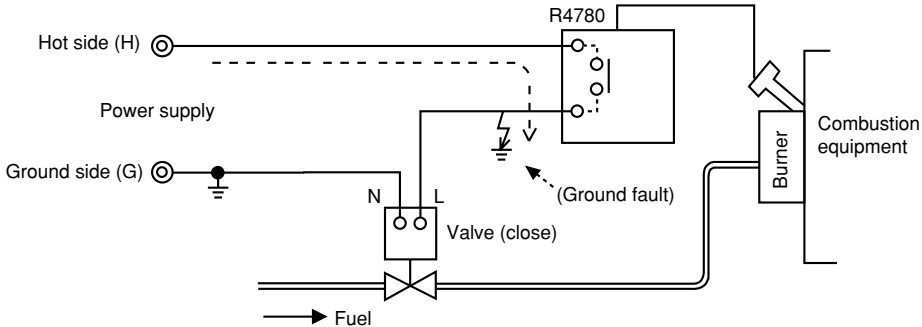
- Fit a #187 tab receptacle on one end of the wire, and keep the wire length as short as possible. Recommended wire: JIS C3306 size 0.75 mm² (size 0.18 mm², 30 strands)
- The mounting bracket on the surge absorber is press-fit internally on the ground side. Mount the mounting bracket on a boiler drum or other grounded metal portion.
- The surge absorber is not waterproof. Do not install where exposed to splashing water.

■ Wiring to a solenoid valve

⚠ WARNING

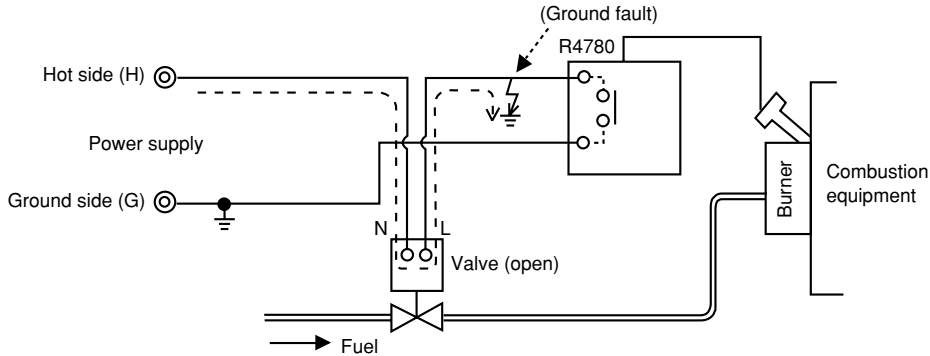
Do not connect a solenoid valve to the hot side of the circuit. If a ground fault occurs, the ground fault current may energize and open the solenoid valve. This device will not be able to prevent the valve from opening and fuel from flowing out.

● Correct connection



When the valve wiring is connected correctly as shown in the figure, ground fault current will not flow through the solenoid valve even if a ground fault occurs due to faulty insulation on the hot side.

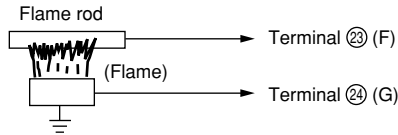
● Wrong connection



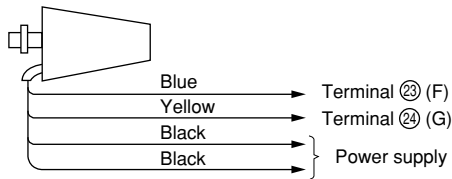
If the valve is wired incorrectly, to the hot side, ground fault current will flow through the solenoid valve if a ground fault occurs, as shown in the figure. In such a case the valve would open to allow the flow of fuel regardless of the signal from the R4780.

● **Wiring to a flame detector**

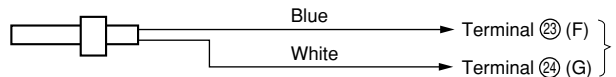
- C7007A, C7008A flame rods



- C7012A ultraviolet sensor

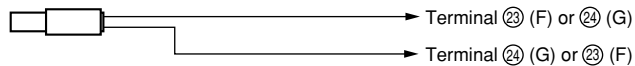


- C7027A, C7035A



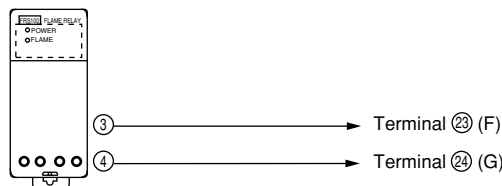
* : Be careful not to reverse the blue and white leads. Doing so can damage the UV tube.

- C554A



* The leads do not have polarity.

- FRS100

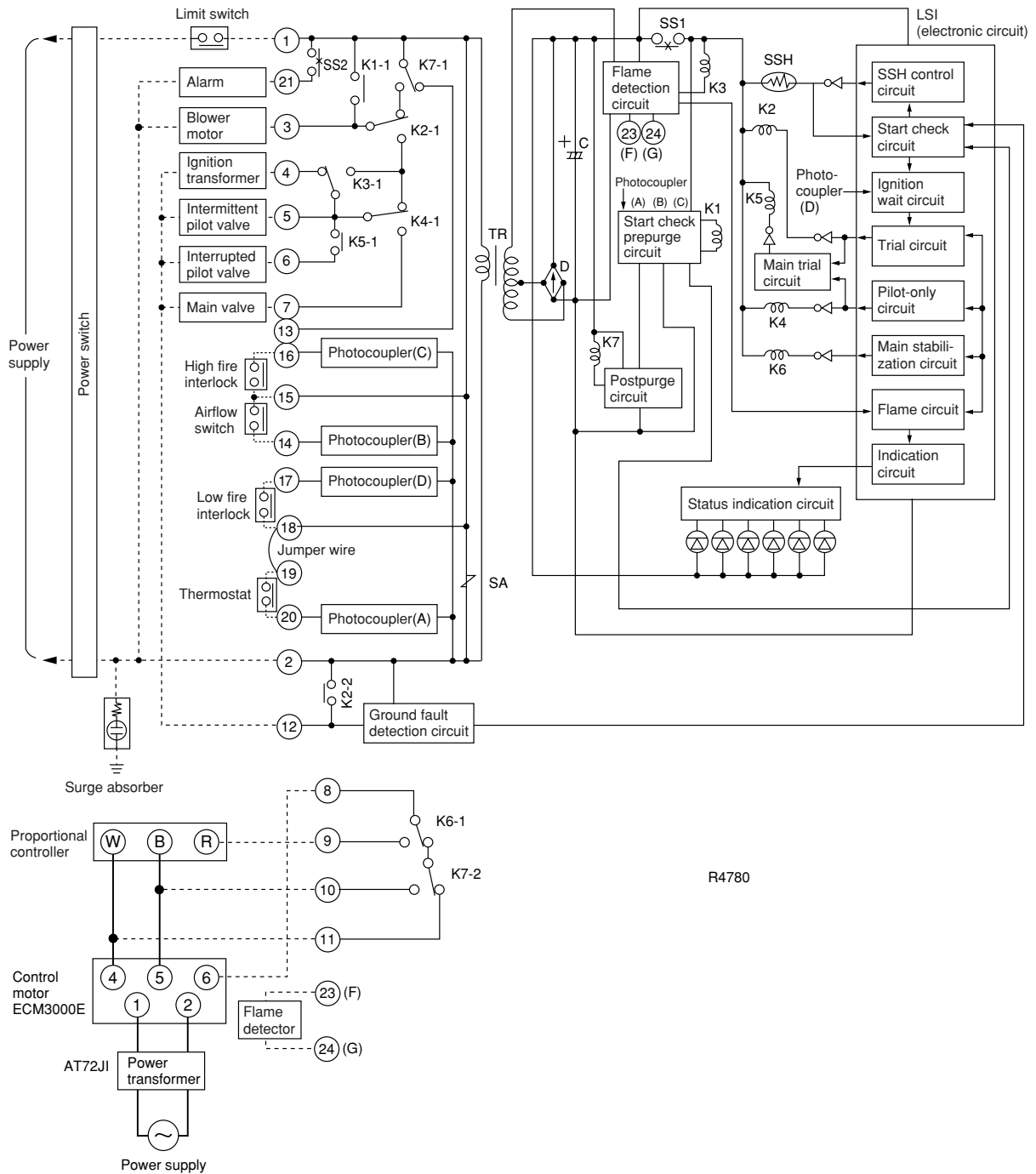


■ **When replacing the R8150B/C with R4780B/C**

- (1) Remove the R8150B/C from the subbase.
- (2) Remove the jumper wire between terminals 16 and 17 on the subbase, and use it to connect terminals 18 and 19.
- (3) Because the connection from terminal 13 to the airflow switch is unnecessary, disconnect it.
- (4) In order to use the ground fault detection circuit, move the wiring from the various loads such as the ignition transformer, pilot valve and main valve, from terminal 2 to terminal 12.
- (5) Plug the R4780B/C into the subbase, and tighten the retaining screw.

Chapter 3. OPERATIONS

■ Example of wiring to external equipment, and internal block diagram



■ Normal operation

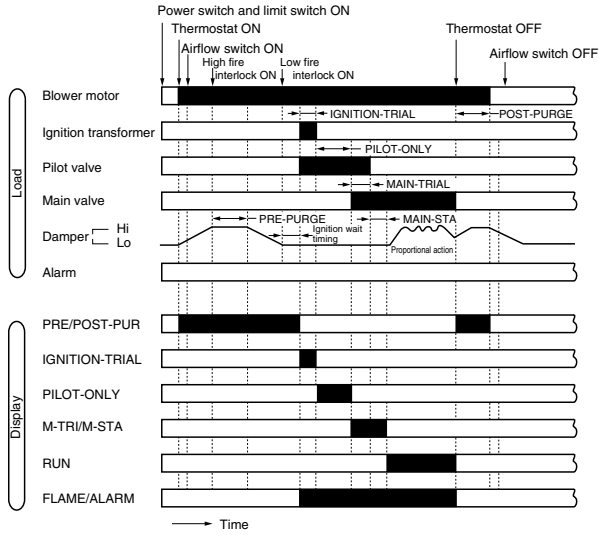
Power switch and thermostat	R4780 operation	Equipment behavior	Status indicators
Power switch ON Limit switch ON	Power is supplied to terminals 1 and 2.		
Thermostat ON	The start check prepurge circuit and the LSI check circuit energize relay K7. The K7-1 contacts switch over to the terminal 3 side, and the K7-2 contacts switch over to the terminal 10 side.	Blower motor starts. Control motor moves toward high fire position. Airflow switch ON if the airflow proves adequate.	PRE-PURGE/ POST-PURGE lights up.
	The length of the prepurge period is ensured by the photocoupler (B) and the start check prepurge circuit.		
	The prepurge timing count is started by the photocoupler (C) and the start check prepurge circuit.	High fire interlock ON	
	After the completion of the prepurge period, relay K1 turns ON and relay K7 turns OFF. The K1-1 contacts close, the K7-1 contacts switch to the terminal 13 side, and the K7-2 contacts switch to the terminal 11 side.	Control motor moves toward low fire position.	
	The LSI ignition wait circuit is activated by means of photocoupler D. After completion of the ignition wait period, relays K2 and K5 are energized by the LSI trial circuit. The K2-1 contacts switch to the terminal 4 side, and both the K2-2 and K5-1 contacts close.	Low fire interlock ON. Ignition transformer operation starts. Intermittent pilot valve or interrupted pilot valve opens (depending on the selection of terminal 5 or 6)	PRE-PURGE/ POST-PURGE turns off. IGNITION TRIAL lights up.
	When the flame detector detects a flame within the ignition trial period, relay K3 is activated by the flame detection circuit and by the LSI flame circuit. The K3-1 contacts switch to the terminal 5 side. Also, the LSI pilot-only circuit is activated.	Ignition transformer operation stops.	FLAME/ALARM lights up. IGNITION TRIAL turns off. PILOT-ONLY lights up.
	After completion of the pilot-only period, relay K4 turns ON. The K4-1 contacts switch to the terminal 7 side.	Main valve opens.	PILOT-ONLY turns off. MAIN TRIAL/ MAIN STA lights up.
	After completion of the main trial period, relay K5 turns OFF. The K5-1 contacts open.	Interrupted pilot valve closes.	
	After completion of the main flame stability period, relay K6 is turned ON by the LSI stability circuit. The K6-1 contacts switch to the terminal 9 side.	Control motor changes to proportional action.	MAIN TRIAL/ MAIN STA turns off. RUN lights.
Thermostat OFF	Relays K1, K2, K3, K4 and K6 turn OFF. Photocoupler A activates the postpurge circuit and turns relay K7 ON. The K1-1 contacts open, the K2-1 contacts switch to the terminal 1 side, the K2-2 contacts open, the K3-1 and K4-1 contacts switch to the terminal 4 side, the K6-1 contacts switch to the terminal 11 side, the K7-1 contacts switch to the terminal 3 side, and the K7-2 contacts switch to the terminal 10 side.	Intermittent pilot valve and main valve close. Control motor moves toward the high fire position.	RUN turns off. FLAME/ALARM turns off. PRE-PURGE/ POST-PURGE lights up.
	After the completion of the postpurge period, relay K7 turns OFF. The K7-1 contacts switch to the terminal 13 side, and the K7-2 contacts switch to the terminal 11 side.	Blower motor stops. Airflow switch turns OFF. Control motor moves toward the low fire position.	PRE-PURGE/ POST-PURGE turns off.
	All circuits return to their initial state, and the device waits for the next ON signal from the thermostat.		

■ Sequence examples

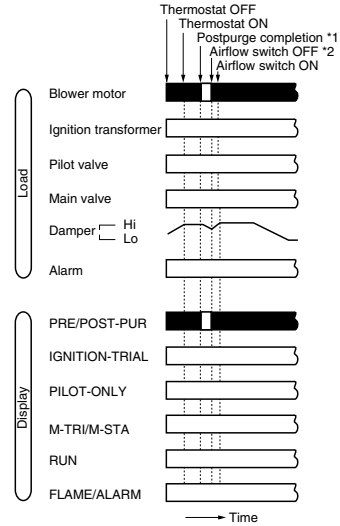
	(page)
• Normal operation	14
• Call for heat during postpurge	14
• Pilot ignition failure	14
• Flame failure during run period	14
• Flame failure during ignition trial	15
• Flame failure during pilot-only period	15
• Flame failure during main trial	15
• False flame signal at the start of operation extends beyond the lockout period.....	15
• False flame signal at the start of operation disappears within the lockout period*	16
• False flame signal occurs during prepurge and extends beyond the lockout period.....	16
• False flame signal occurs during prepurge but disappears within the lockout period*	16
• False flame signal occurs during the ignition wait period and continues beyond it	16
• Airflow switch turns OFF and then ON again during prepurge	17
• Airflow switch turns OFF and then ON again within the ignition wait period	17
• Airflow switch turns OFF and then ON again during the ignition trial	17
• Airflow switch turns OFF during the ignition trial	17
• Airflow switch turns OFF during the pilot-only period	18
• Airflow switch turns OFF during the main trial	18
• Airflow switch turns OFF during the RUN period.....	18
• High fire interlock does not go ON at first, but goes ON later	18
• Low fire interlock does not go ON at first, but goes ON later	19
• Low fire interlock turns OFF during the ignition trial	19
• Low fire interlock turns OFF during the pilot-only period	19
• Low fire interlock turns OFF during the main trial.....	19
• Low fire interlock turns OFF during the RUN period	20
• Ground fault is detected at startup	20
• Both high fire interlock and low fire interlock go ON during the prepurge	20

*: Examples of the R4780B/D/F. The R4780C goes into lockout.

● Normal operation

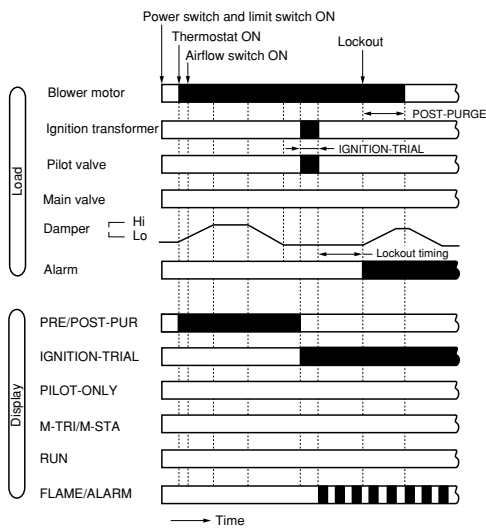


● Call for heat during postpurge

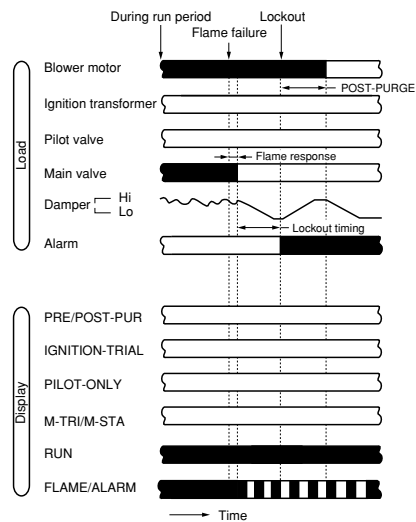


- *1. Even if the thermostat turns ON during the postpurge, the timing of the postpurge period continues unchanged.
- *2. The sequence restarts from the beginning after the airflow switch turns OFF.

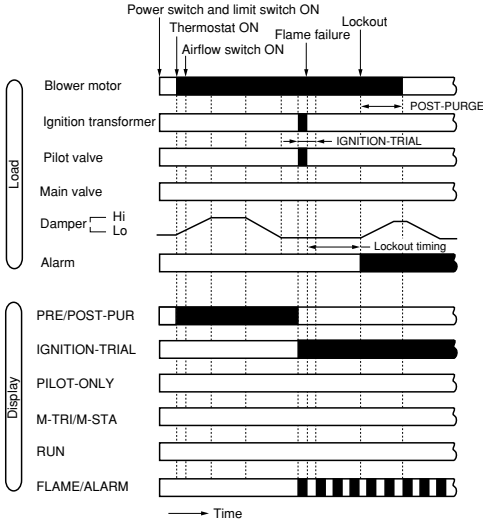
● Pilot ignition failure



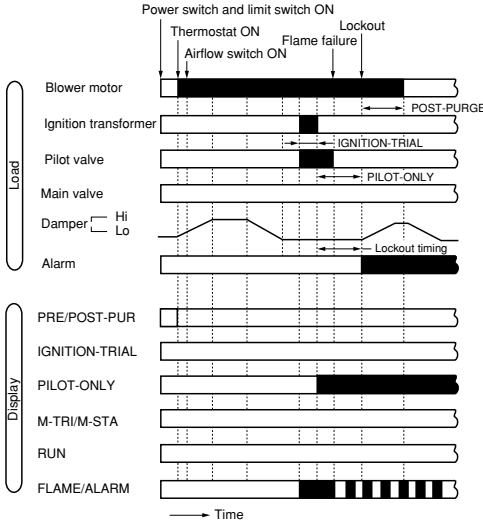
● Flame failure during run period



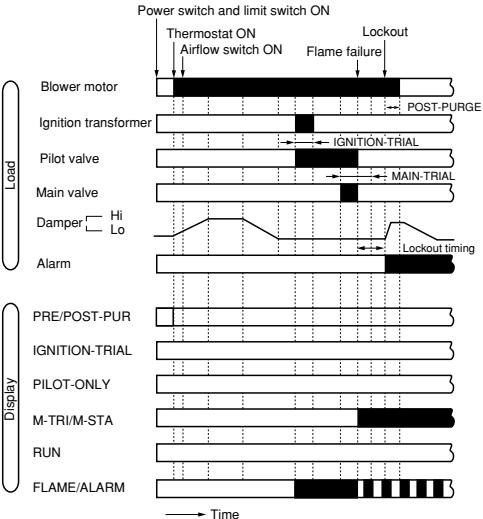
● Flame failure during ignition trial



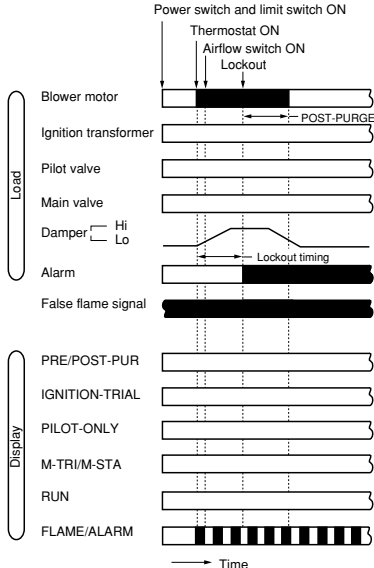
● Flame failure during pilot-only period



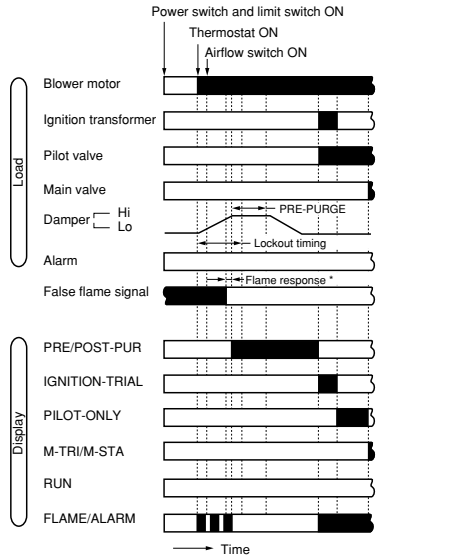
● Flame failure during main trial



● False flame signal at the start of operation extends beyond the lockout period



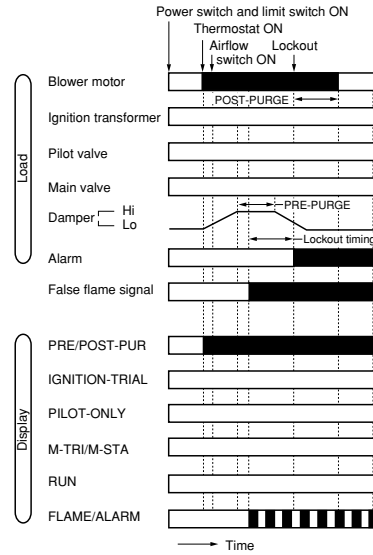
- False flame signal at the start of operation disappears within the lockout period



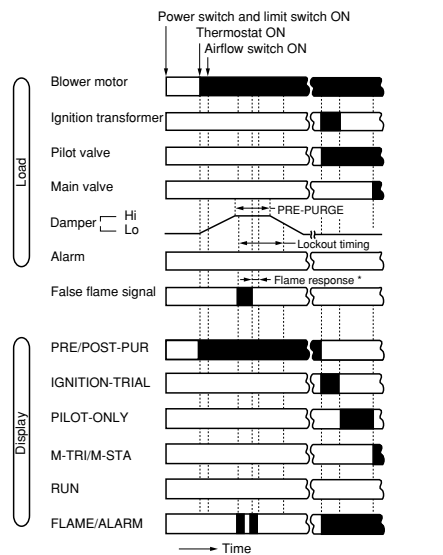
* : The sequence resumes normally after the flame response period.

The example shown is for the R4780B/D/F.
The R4780C goes into lockout.

- False flame signal occurs during prepurge and extends beyond the lockout period



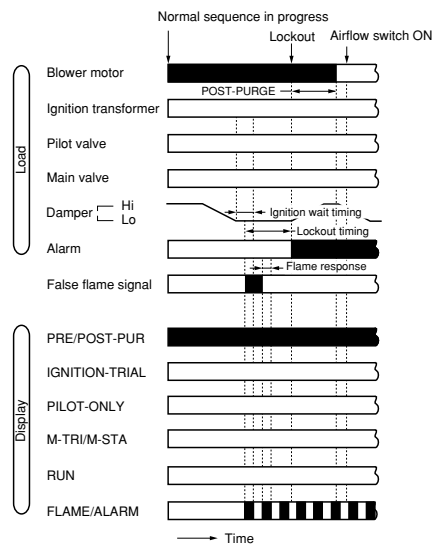
- False flame signal occurs during prepurge but disappears within the lockout period



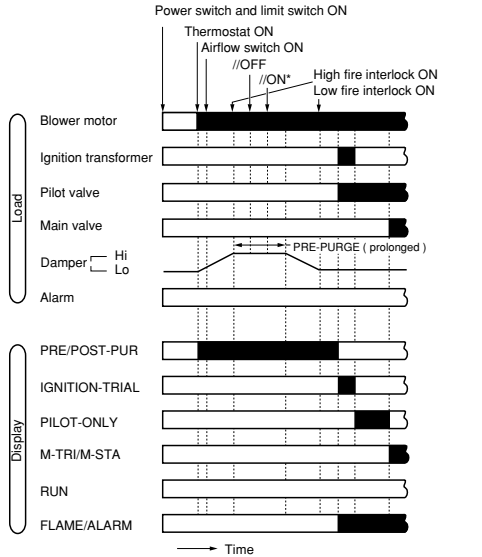
* : The sequence resumes normally after the flame response period.

The example shown is for the R4780B/D/F.
The R4780C goes into lockout.

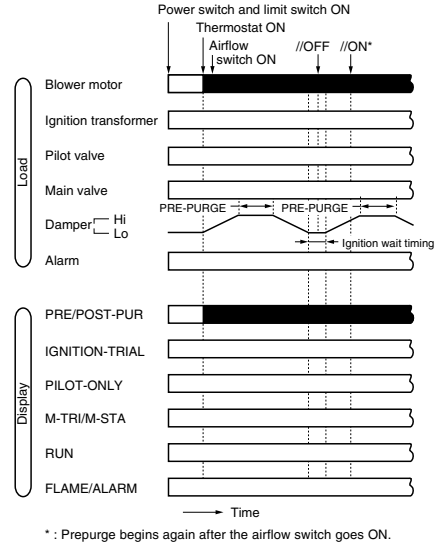
- False flame signal occurs during the ignition wait period and continues beyond it



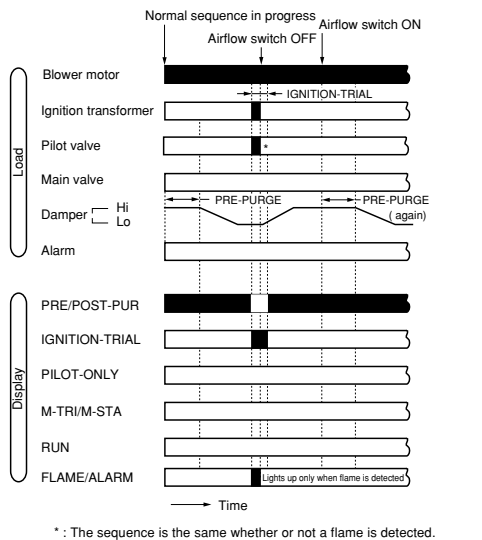
● Airflow switch turns OFF and then ON again during prepurge



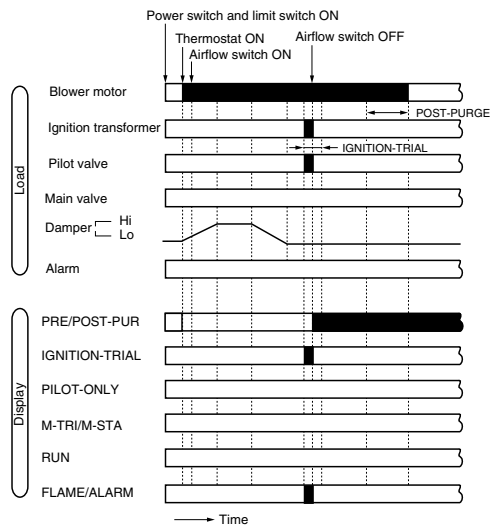
● Airflow switch turns OFF and then ON again within the ignition wait period



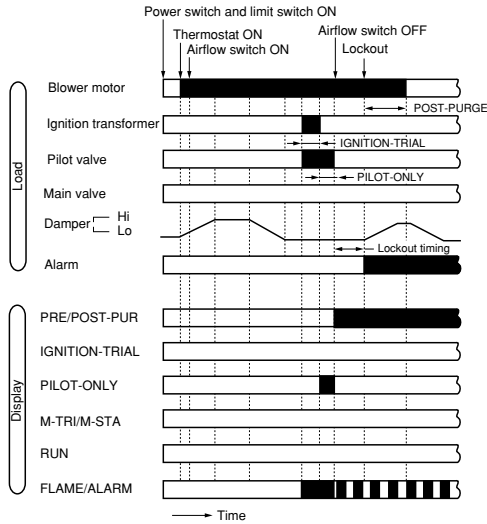
● Airflow switch turns OFF and then ON again during the ignition trial



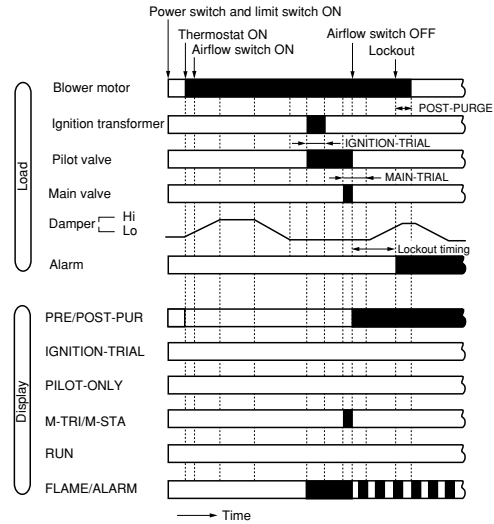
● Airflow switch turns OFF during the ignition trial



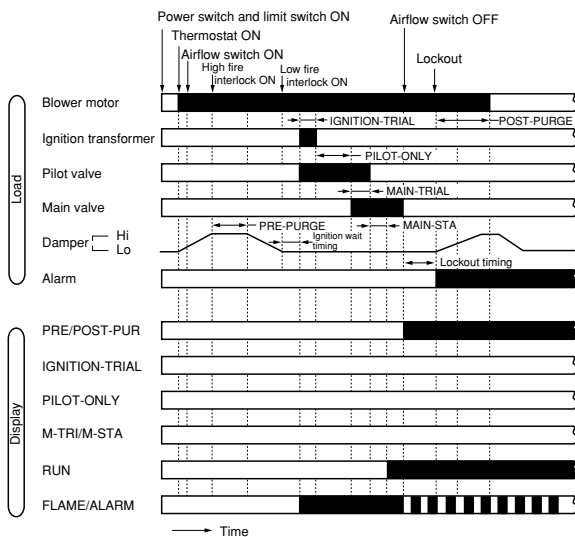
● Airflow switch turns OFF during the pilot-only period



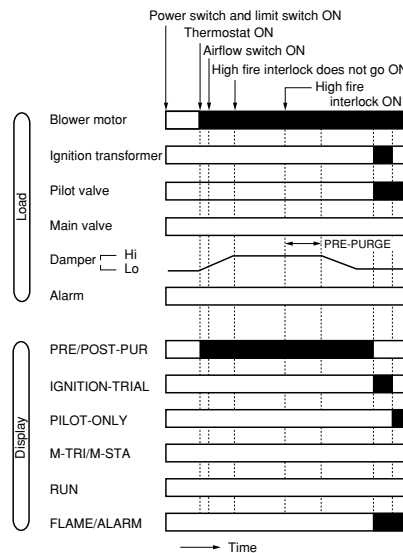
● Airflow switch turns OFF during the main trial



● Airflow switch turns OFF during the RUN period

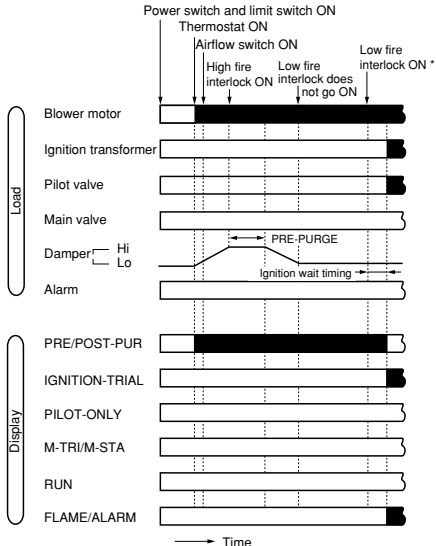


● High fire interlock does not go ON at first, but goes ON later



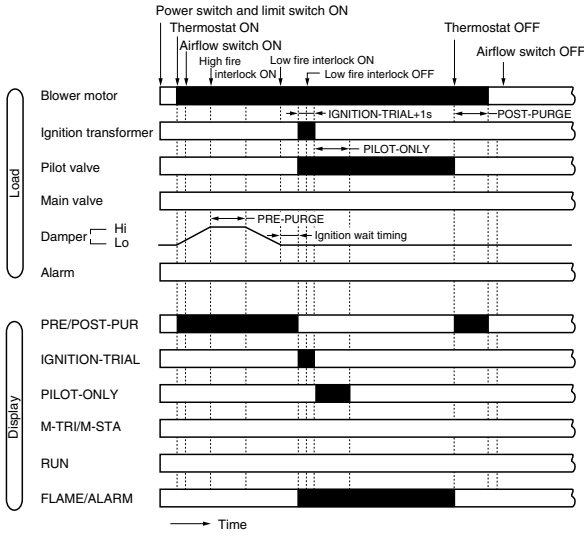
* : Timing of the prepurge does not begin until the high fire interlock turns ON. Thereafter the sequence resumes normally.

● Low fire interlock does not go ON at first, goes ON later



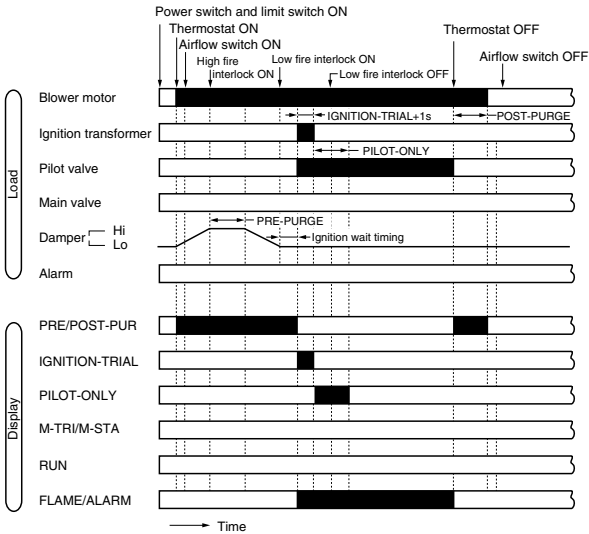
*: Timing of the ignition wait period does not begin until the low fire interlock turns ON. Thereafter the sequence resumes normally.

● Low fire interlock turns OFF during the but ignition trial



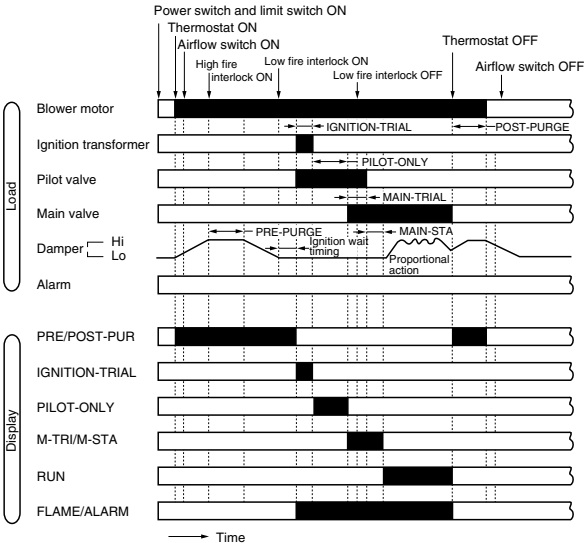
*: The timing of the pilot-only period continues unchanged. If the low fire interlock turns ON again during the pilot-only period, the sequence resumes normally.

● Low fire interlock turns OFF during the pilot-only period

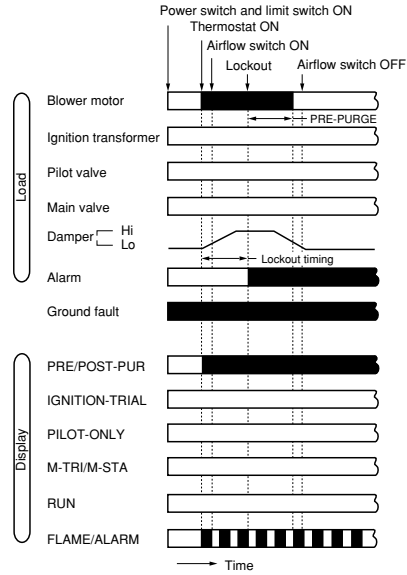
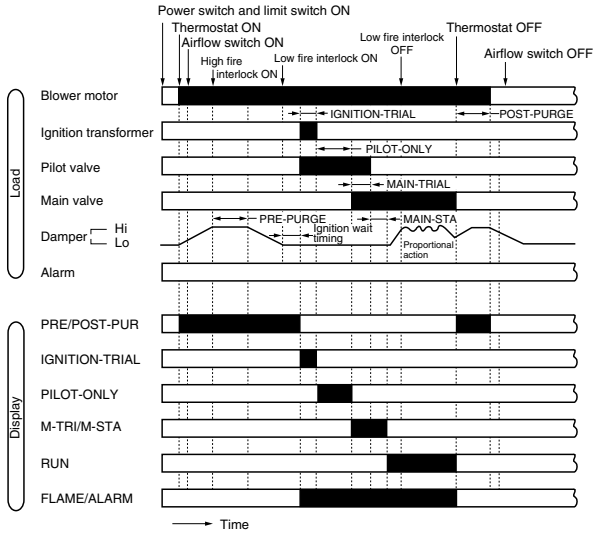


*: The timing of the pilot-only period continues unchanged. If the low fire interlock turns ON again during the pilot-only period, the sequence resumes normally.

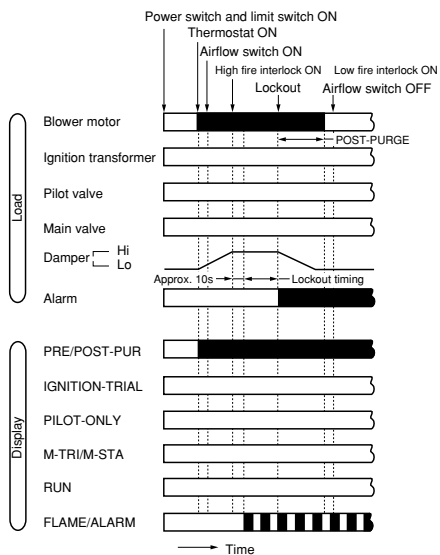
● Low fire interlock turns OFF during the main trial



- Low fire interlock turns OFF during the RUN period
- Ground fault is detected at startup



- Both high fire interlock and low fire interlock go ON during the prepurge



Chapter 4. TRIAL RUN AND ADJUSTMENT

WARNING



Do not touch the terminals during the power is charged. Doing so might cause an electric shock.



Do not touch the terminals during trial-run adjustments. Doing so might cause an electric shock.



Before the pilot turndown test or ignition spark response test, make sure that all manual fuel valves are closed.



Even after the power to this device is turned off, terminal F continues to hold an electrical charge. To avoid electrical shock, do not touch terminal F.



If the pilot turndown test must be carried out repeatedly, completely shut down all equipment each time the test is finished, and completely discharge unburned gas or fuel that has accumulated in the ducts and combustion chamber. Failure to discharge unburned gas or fuel may result in an explosion.



When the pilot turndown test is complete, turn OFF the power switch to shut down the power. Restore all test jumpers and limit interlock/regulator settings to their previous states. If operation begins without the above steps, damage to the equipment, gas leak or explosion may result.

CAUTION



Only an experienced technician who has knowledge and technical skills related to combustion equipment and combustion safety should carry out the pilot turndown test.

■ Preliminary check

Check the items below.

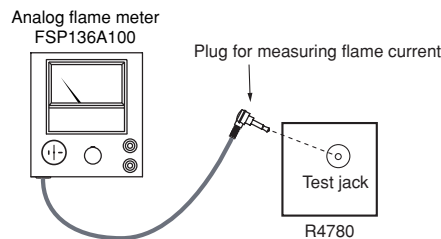
- Temperature and humidity are within the allowable range.
- There are no mistakes in the wiring, and no loose terminal screws.
- The flame detector is installed correctly.
- The burner is adjusted correctly.
- There are no obstacles, screens, etc. blocking the combustion air intake or exhaust.
- Electric power voltage and frequency conform to what is indicated on the equipment.
- The safety switch on the R4780 has been reset. (Press the red reset button on the front panel.)

■ Test procedures

Carefully check and/or adjust the following items in order to operate the combustion equipment safely.

● Flame current check

The flame current check is the best way to discriminate between good and unacceptable installation of the flame detector. The check should be done after installation and during maintenance. If the flame current is checked at least once per month, shutdown due to insufficient flame current can be prevented.



Insert the plug from the analog flame meter into the test jack on the front of the R4780 as shown in the figure. (Pull lightly with your fingernail to remove the jack cover. After measuring the flame current, put the cover back in place.)

Operate the burner and then measure the flame current. Normally, it is 2 to 10 μA . The flame current indicated in the specifications (page 29) is the necessary minimum value, and additionally the flame current must be stable. Make sure that the meter needle does not fluctuate widely. If the current is not steady, check carefully for the following possible causes:

When using a flame rod

- Voltage and/or frequency of supplied power is unsuitable
- Gas pressure and/or air-fuel ratio is unsuitable
- Defective connection between the flame rod and burner
 - Open circuit
 - Short circuit
 - Deteriorated insulation due to humidity or dirt
- Improper installation of flame rod
 - Improper flame contact area
 - Unsuitable position of flame rod in flame
 - Flame rod insulator is too hot (315 °C or more)
- Ignition transformer effects

If the ignition transformer (8 to 10 kVac) and the signal cable of the flame rod are near each other, the ignition transformer absorbs electrons from the flame, so that there might not be an adequate flame current. Additionally, the high voltage of the ignition transformer may cause a spark to the flame rod, damaging the R4780.

C7012A, C7027A or C7035A ultraviolet flame detector

- Voltage and/or frequency of supplied power is unsuitable
- Gas pressure and/or air-fuel ratio is unsuitable
- Inappropriate flame monitoring direction
- Soiled photo sensor surface
- Deteriorated UV tube or defective flame detector
- Atmosphere that prevents the transmission of UV rays due to vapor, smoke, atomized oil, dust, etc.

● Pilot turndown test (method 1)

- Required items: A switch with lead wire



Note

- This test is designed to determine the smallest pilot flame (lowest gas and air pressure) which will light the main burner reliably when the flame detector detects the pilot flame.



Handling Precautions

- Before doing the pilot turndown test, determine whether the pilot burner is an intermittent pilot or an interrupted pilot. If it is an interrupted pilot, either jumper terminals 5 and 6 together or reconnect the wire going to the pilot valve from terminal 6 to terminal 5 to ensure that the pilot burner continues to burn after the main burner has ignited. After completion of the test, be sure to return the jumper or wire to its original state.
- Before and after this test, measure the flame current and make sure that it is at the standard flame current level or higher.

- (1) Turn the power switch off to stop all equipment.
- (2) Set the main valve to "closed" (either remove one of the wires to the main valve, or set the manual cock to "closed"), so that the supply of fuel to the main burner is and shut off. Leave the pilot valve in the normal position.
- (3) Turn the power switch on. If both the limit switch and the thermostat are ON, the equipment starts. After the prepurge is complete, the pilot valve opens and ignition action starts simultaneously. (IGNITION-TRIAL lights.)
- (4) After the pilot burner starts combustion and ignition action stops (IGNITION-TRIAL turns off), gradually close the pilot valve (manual cock) until the R4780 causes the flame failure shutdown action. Make a mark on the manual cock at the point where the shutdown is made. Then press the reset button and reset the safety switch to start the operation again. Return the manual cock to a point just before that where the previous mark was made (in the direction of greater fuel flow).
- (5) Turn the power switch off and return the main valve to the normal condition, then turn the power switch on again. After the prepurge, the pilot burner ignites, followed by the main burner. If the main burner does not ignite at this point, immediately turn the power switch off. The cause of this failure to ignite is that the pilot flame is too small, and therefore must be made larger. In such a case, if a flame rod is used for flame detection, adjust the position of the flame rod by moving it only slightly away from the center axis of the pilot flame toward the outside. For the C7012A, C7027A or C7035A flame detector, adjust the mounting position by moving the flame detector very slightly away from the previous monitoring axis of the pilot flame.
- (6) After adjusting the mounting position of the flame detector, once again carry out steps (1) to (5), and check to see whether or not the main burner ignites properly.

● **Pilot turndown test (method 2)**

- (1) Same as steps (1) and (2) of method 1.
- (2) Put the switch with lead wires between terminals 17 and 18, in series with the low fire interlock, and turn the switch on.
- (3) Same as step (3) of method 1.
- (4) After the pilot burner ignites, turn the switch off. Then ignition operation will stop, and the equipment will be in a pilot-only state. The subsequent procedure is the same as step (4) of method 1. To restart combustion after the R4780 has shut it down, turn the switch ON. The sequence will restart from a low fire interlock ON condition, and after 5 to 10 seconds, the ignition process will start. After the pilot burner ignites, turn the switch off.
- (5) Same as step (5) of method 1.
- (6) After adjusting the position of the flame detector, do steps (1) to (5) of method 2 again. After confirming that the main burner properly ignites, turn the power switch off. Remove the switch from between terminals 17 and 18, and restore the wiring of the low fire interlock to its original state.

● **Safety shutdown check**

- (1) Limit switch operation check
Reducing the setting of the limit switch of an operating boiler or a furnace should cause a normal safety shutdown. After confirming that a safety shutdown occurs, restore the original limit switch setting. The burner should go through a normal prepurge and start.
- (2) Flame failure check
Close the manual fuel cock while the burner is operating. After the flame response period, the pilot valve and main valve will be closed. Then, after the lockout period, the sequence will be locked out. After confirming that this occurs, open the manual cock. After the safety switch has cooled down, push the reset button. The burner will start again.
- (3) Power cut (power failure) check
Turn the power switch off while the burner is operating normally. The burner should stop combustion. Wait for a short while, and then turn the power switch ON. The burner should start again.

Chapter 5. MAINTENANCE AND INSPECTION

WARNING



Do not touch the terminals during the power is charged. Doing so might cause an electric shock.



Even after the power to this device is turned off, terminal F continues to hold an electrical charge. To avoid electrical shock, do not touch terminal F.



When the safety switch operates or the lockout occurs, reset after removing the causes. However do not reset repeatedly. Doing so might cause a serious accident of the combustion equipment.

CAUTION



If the safety shutoff has been activated, check all of the items on the checklists in chapter 4, TRIAL-RUN ADJUSTMENT before restarting the equipment.



Do not disassemble the device. Doing so might cause faulty operation or electric shock.

■ General items

Handling Precautions

- Never lubricate any part of the R4780.

(1) Remove burnt matter from the flame rod, burner, etc.

(2) Wipe away dirt from the light-sensing surface of the flame detector.

(3) If the R4780 is replaced with a new one, carry out all checks and adjustments, including the important items listed in chapter 4.

■ Maintenance and inspection intervals

Determine the maintenance and inspection intervals taking into account the type of combustion equipment, the conditions existing in the vicinity of the R4780, and the frequency of operation. A rough guide is given below.

Inspection Procedure	Interval
Cleaning light-sensing surface of flame detector	At least once a month, or as necessary
Cleaning the flame rod and the burner	At least once a year*
Checking safety shutdown and flame failure behavior	At least once a month
Measuring the flame current	At least once a month

*After cleaning, be sure to do the pilot turndown test.

■ Troubleshooting procedure

When checking the cause of a problem, follow the procedure below.

- (1) Turn the power switch off and turn the thermostat off.
- (2) Push the Protectorelay reset button and reset the safety switch.
- (3) Turn the power switch ON. Check that the prescribed voltage is present between terminals 1 and 2 when the limit switch turns on.
- (4) If the voltage between terminals 1 and 2 is zero, check the limit switch, fuse, power switch and supply voltage.
- (5) Adjust the set point of the thermostat so that it turns on.
- (6) Check the operation of relay K7 by the following procedure:
 - When relay K7 is energized, voltage should be applied between terminals 3 and 2 through contacts K7-1, starting the blower motor. Also, by way of contacts K7-2, the control motor should move the equipment to the high fire position (with PRE-PURGE/POST-PURGE lit up). If the blower motor is running, go to step (7).
 - If the blower motor does not start, check whether there is voltage between terminals 3 and 2.

If there is voltage (if PRE-PURGE/POST-PURGE lights up), check the wiring to the blower motor and also the blower motor itself. If there is no voltage (PRE-PURGE/POST-PURGE does not light up), check the wiring to the thermostat as well as the thermostat itself. Try to jumper terminals 19 and 20. If the blower motor starts, and the control motor drives toward high fire position and starts (with PRE-PURGE/POST-PURGE lit), the thermostat is probably defective and should be replaced.

If, despite the connection of terminals 19 and 20, the blower motor does not start, and if the control motor does not drive toward high fire position and start (PRE-PURGE/POST-PURGE does not light up), there is a problem with the R4780, which must be replaced.

- If the blower motor does not start even though the thermostat turns ON, and the safety switch locks out after the lockout period, go to step (14).
- (7) Check if the airflow switch operates normally.
 - If the airflow switch operates normally, timing of the prepurge period will start after the high fire interlock turns on, and after the completion of the prepurge period, the control motor will begin to move toward the low fire position.
 - If the air flow switch does not operate, adjust it so that it goes ON. If it is not possible to turn the switch on, it is defective and must be replaced.
 - (8) Check that the high fire interlock operates normally.
 - If the interlock operates normally, go to step (9).
 - If the interlock does not go on despite adjustment, it is broken and must be replaced. (If a high fire interlock is unnecessary, jumper terminals 15 and 16.)

(9) Check that the low fire interlock operates normally.

- If the interlock operates normally, the ignition process will start (IGNITION-TRIAL will light up). Go to step (10).
- If the interlock does not go on despite adjustment, it is broken and must be replaced. (If a low fire interlock is unnecessary, jumper terminals 13 and 17.)

(10) If the pilot burner does not ignite, check if there is voltage between terminals 4 and 12, and between terminals 5 and 12 (or 6 and 12).

- If there is voltage (IGNITION-TRIAL lights up), check the wiring between the pilot valve and terminals 5 and 12 (or 6 and 12).
- If there is no voltage, there is a problem with the R4780, which must be replaced.

! Handling Precautions

- When using an interrupted pilot (with wiring connecting terminal 6 to the pilot valve), be sure to jumper terminals 5 and 6. After the inspection procedure, be sure to remove the jumper.

(11) Flame detection system check

- If the flame detection circuit operates normally after the pilot burner ignites, the main burner will light after the pilot-only period. After the main trial period, the interrupted pilot will be shut off, the control motor will start combustion control in response to signals from the proportional controller, and the equipment will begin the normal combustion operation. If the C7012A, C7027A or C7035A is used, and if the spark from the ignition transformer is detected but the pilot burner does not ignite, the pilot burner will be shut down during the pilot-only period. After the lockout period, the sequence will be locked out.
- If the flame detection circuit is not activated, the voltage to the ignition transformer and pilot burner will be cut off after the ignition trial period. After the lockout period, an alarm will be emitted, and after the postpurge period, the R4780 will stop.

Reset the safety switch to restart the R47800 and measure the flame current. If the flame current is too low, check each item listed on page 22. If there is sufficient flame current, there must be a problem with the R4780. Replace the R4780.

(12) Confirmation of sequence operation

After the pilot burner ignites, check the operation of the main valve. If the main valve does not open, check that there is voltage between terminals 7 and 12.

- If there is voltage (if MAIN-TRIAL/MAIN-STA lights up), check the wiring between the main valve and the terminals.
- If there is no voltage, there is a problem with the R4780. Replace the R4780.

(13) If an interrupted pilot is used (wiring connects terminal 6 to the pilot valve), check that the pilot burner is shut off after the main trial period.

(14) If a false signal is emitted at startup

If a flame signal is emitted after the thermostat turns on, causing the flame circuit to operate the SSH control circuit of LSI, and if the false flame signal continues after the lockout period has ended, the sequence will be locked out and an alarm will be emitted (FLAME/ALARM will flash).

- Check the flame detector. If it is damaged, replace it.
- If the flame detector is normal, the R4780 is faulty. Replace the R4780.

(15) If a ground fault is detected in the ignition transformer or valve at startup (if PRE-PURGE/POST-PURGE lights up and FLAME/ALARM blinks)

- Remove the wiring from terminal 12.
- If the status indicator (FLAME/ALARM) stops blinking, remove the wiring to the ignition transformer and valve in turn. If the indicator stops blinking, the wiring is the cause. Replace it.
- If the status indicator (FLAME/ALARM) does not stop blinking, the problem might be a ground fault in the subbase or a problem with the R4780. Check the mounting and wiring, or replace the R4780.

! Handling Precautions

- The same pattern of indicator lights is seen if the low fire interlock contacts become contact welding.

Chapter 6. SPECIFICATIONS

■ Specifications

Model No.	R4780B1003-1	R4780B1011-1	R4780C1001-2	R4780C1019-2	R4780D1009-1	R4780D1017-1	R4780F101-2	R4780F119-2
Item								
Compatible equipment	Batch-operation oil-fired, gas-fired and oil-gas fired combustion equipment with a capacity of 350 kW or more							
Rated voltage, frequency	100 Vac, 50/60 Hz	200 Vac, 50/60 Hz	100 Vac, 50/60 Hz	200 Vac, 50/60 Hz	100 Vac, 50/60 Hz	200 Vac, 50/60 Hz	100 Vac, 50/60 Hz	200 Vac, 50/60 Hz
Allowable voltage	85 to 110% of rated voltage							
Compatible flame detector	Flame rod: C7007A, C7008A Ultraviolet sensor: C7012A		Compact ultraviolet sensor: C7027A, C7035A		With cadmium sulfide cell: C554A, CN120A, CN700A		Contact input, • FRS100B104/204 and flame rod or C7012A or • FRS100C104/204 and C7035A or C7027A (flame response 2s max.)	
Flame current	2 to 6 μ A (at test jack) Flame detection sensitivity: 1 μ A or less Non-flame detection sensitivity: 0.2 μ A or more		4 μ A or more (at test jack) Flame detection sensitivity: 2 μ A or less Non-flame detection sensitivity: 0.8 μ A or more		(Not applicable.) Flame detection sensitivity: 2 k Ω or more Non-flame detection sensitivity: 10 k Ω or less		(Not applicable.) Flame detected: terminal 23-24 connection closed Flame-out detected: terminal 23-24 connection open	
Prepurge	35 \pm 5 s							
Ignition wait	7.5 \pm 2.5 s							
Ignition trial	4 \pm 1 s							
Pilot-only	8.5 \pm 3.5 s							
Main trial	6.5 \pm 2 s							
Main (stabilized)	8.5 \pm 3.5 s							
Postpurge	20 \pm 8 s							
Lockout	30 s or less							
Flame response	1.5 \pm 0.5 s (at flame current of 2 μ A)		1.5 \pm 0.5 s (at flame current of 8.5 μ A)		1.5 \pm 0.5 s (at flame sensitivity of 1 k Ω)		3 s max. (when used with the FRS100)	
Lockout behavior	In cases of false flame signal detection during prepurge, ignition failure (no ignition), or abnormal flame failure during combustion, the R4780 operates the safety switch and locks out the system.							
Flame failure sequence	No recycling. (May be used with either interrupted pilot or intermittent pilot.)							
Ground fault detection resistance	10 k Ω or more (at normal temperature and humidity, at rated voltage)							
Lightning surge protection	10 kV, 1.2/50 μ s (JEC-212, surge impedance: 75 Ω min.) surge absorber between ground and one side (terminal 2) of power supply.							
Power consumption	11.25 W max.							
Insulation resistance	50 M Ω or more with a 500 Vdc megger, between each terminal (except terminals 23 and 24) and ground.							
Dielectric strength	1500 Vac for 1 min or 1800 Vac for 1 s between each terminal (except terminals 23 and 24) and ground. (Note)							
Allowable ambient temperature	-20 to +60 $^{\circ}$ C							
Allowable storage temperature	-25 to +70 $^{\circ}$ C							
Allowable ambient humidity	90 % or less at 40 $^{\circ}$ C							
Vibration resistance	4.9 m/s ² or less, 10 to 55 Hz, 2 h each in X, Y, Z directions							
Shock resistance	300 m/s ² or less (durability)							
Color	Light gray							
Mass	Approximately 1.0 kg							
Mounting	Plugs in to subbase, which is attached with screws							
Mounting direction	Unrestricted, except that reset button cannot face downward							
Accessories	• Subbase • Surge absorber (model No. 83968019-102)		• Subbase • Surge absorber (model No. 83968019-001)					

Note: When testing dielectric strength test, remove the surge absorber wiring from the terminal.

● **Contact ratings**

Load	Blower motor	Ignition transformer	Intermittent pilot valve	Interrupted pilot valve	Main valve	Control motor	Alarm	Total load during normal combustion run
Terminal No.	3	4	5	6	7	8,9,10,11	21	6 A max
Contacts rating	120 Vac, 4 A 240 Vac, 2 A	400 VA	400 VA	400 VA	800 VA	200 VA	75 VA	

● **Optional devices (sold separately)**

Name	Model No.	Compatible devices
Flame simulator	123514A	C7007A, C7008A, C7012A
	123514B	C7027A, C7035A
	FSP300C	AUD300, AUD500, C7027A, C7035A
Analog flame meter	FSP136A100	R4780B/C

● **Maximum length of flame signal wire**

Flame detector	RG-11/U	2 mm ² IV cable	Description
C7007A, C7008A	Approximately 30 m	–	RG11U equivalent: high-frequency coaxial cable 5C2V or 7C2V
C7012A	Approximately 50 m	–	
C7027A, C7035A	–	Approximately 200 m	IV cable: 600 Vac wire with indoor PVC insulation

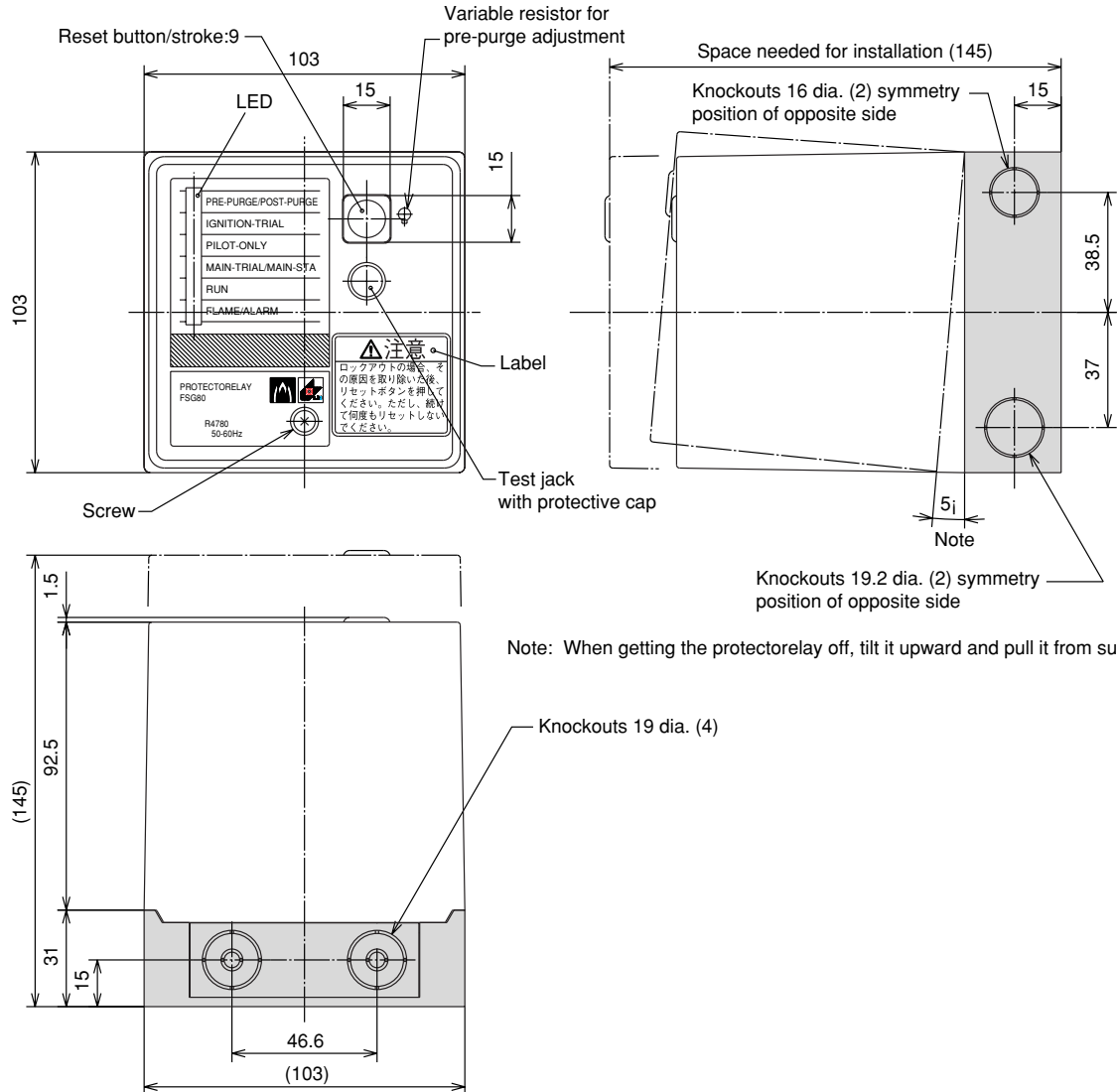
Caution: Keep the flame signal wire separate from the high-voltage ignition wire and power wires. Do not run them through the same conduit.

● **Surge absorber**

Protectorelay model	R4780B	R4780C/D/F
Surge absorber model	83968019-102	83968019-001
Discharge start voltage	1000 ± 200 V	1500 ± 300 V
Initial insulation resistance	50 MΩ min. with 500 Vdc megger	
Insulation resistance at end of life span	1 MΩ min. with 500 Vdc megger	
Allowable ambient temperature	-20 to +60 °C	
Allowable ambient humidity	90 % RH or less at 40 °C	

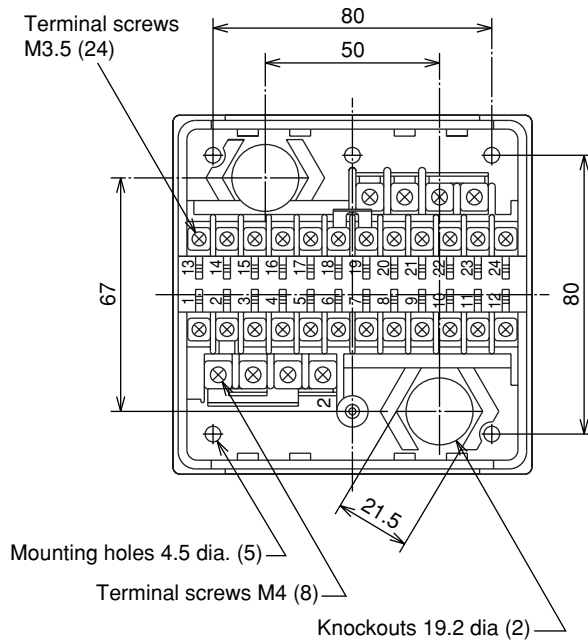
External dimensions

Unit: mm



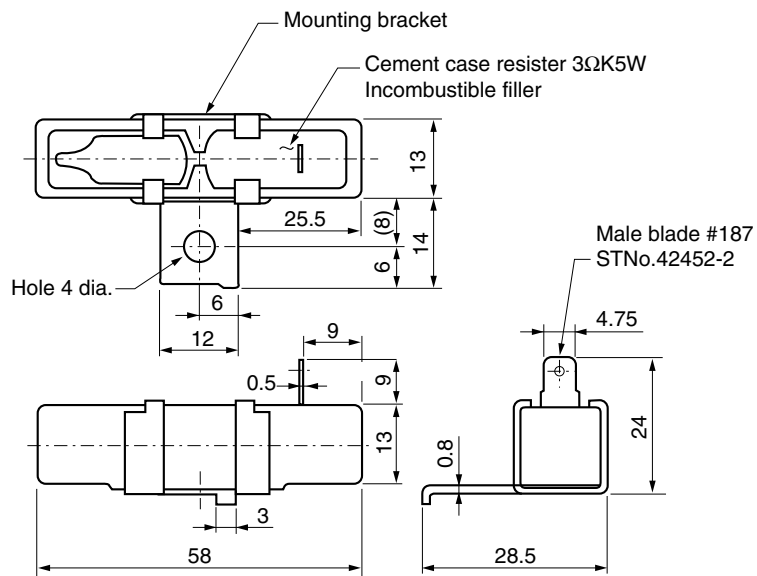
● Subbase

Unit: mm



● Surge absorber

Unit: mm



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Specifications are subject to change without notice. (08)

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