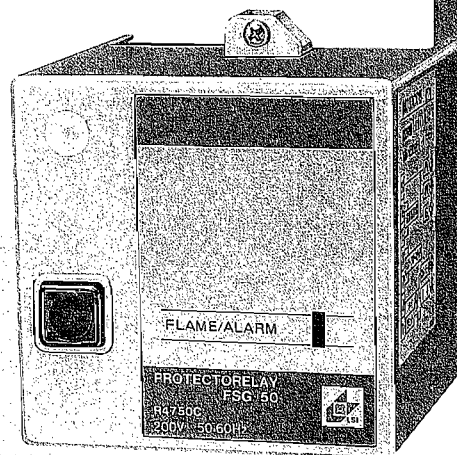


R4750C PROTECTORELAY FSG50 Combustion Safety Controller User's Manual



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.

Caution of Use

- (1) This protectorelay has very important functions to ensure safe operation of combustion equipments. Use it correctly according to this instruction manual.
- (2) The installation, wiring, maintenance, inspections, adjustment, and other jobs of this protectorelay should be carried out by experienced specialist technicians who are familiar with the knowledge and technology of combustion equipments and combustion safety device (protectorelay).

CONTENTS

1. GENERAL	1
2. EXTERNAL DIMENSIONS AND INSTALLATION DIMENSIONS	2
3. INSTALLATION AND WIRING	2— 3
(Replacing R8398D with R4750C)	3— 4
4. OPERATION	5— 7
5. INSPECTION AND ADJUSTMENT	8— 9
6. MAINTENANCE AND INSPECTION	9
7. SPECIFICATIONS	10

1.

GENERAL

The FSG50 protectorelay the R4750C is designed as a combustion safety device to automatically operate either oil-fired or gas-fired combustion equipment having a maximum combustion rate of 580kW.

- It indicates the combustion conditions by LED lamps on the FRAME/ALARM indicator.
- A ground fault detection circuit is provided to ensure safety of power polarity when a ground fault occurred in a safety shutoff valve, an ignition transformer, and other parts.
- Owing to a fail-safe start safety circuit, this protectorelay is not started, if an internal or external circuit is defective or if a false flame signal is generated.
- If the equipment is locked out due to an ignition failure, an abnormal flame failure, or other failures, so long as the equipment is reset manually.

2. EXTERNAL DIMENSIONS AND INSTALLATION DIMENSIONS

External Dimensions

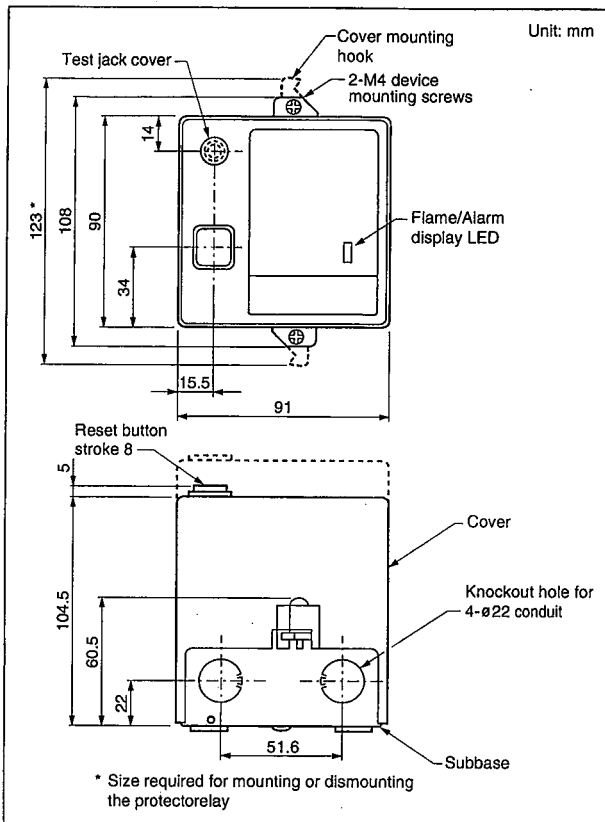


Fig. 1

Subbase mounting dimensions and terminal layout

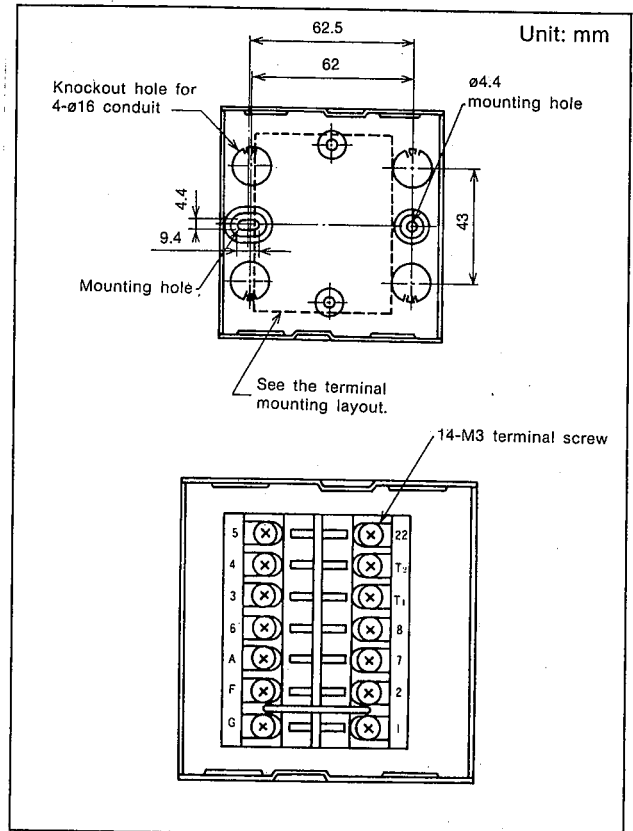


Fig. 2

3. INSTALLATION AND WIRING

Cautions

- (1) Don't install the protectorelay at the following places:
 - ① A place where there are special chemicals or corrosive gases (ammonia, sulfur, chlorine, ethylene compounds, acids, etc.).
 - ② A very wet place or a place exposed to water drops.
 - ③ A place subjected to a high temperature.
 - ④ A place subjected to vibrations for a long time.
- (2) Installation and wiring the protectorelay according to this instruction manual or the instruction manual supplied by the set maker (boiler maker, etc).
- (3) Connect cables according to the specified standards.
- (4) Connect the power cable last so as to prevent an electric shock or damage. If the power cable touches other terminals accidentally, a trouble or damage may occur.
- (5) Set the load to be connected to each terminal to be lower than the rated load.
- (6) Supply power to the protectorelay having the same voltage and frequency as those specified on the equipment label.
- (7) Select reliable timers, auxiliary relays, etc. to provide additional functions, if necessary, and connect them correctly to circuits.
- (8) Be sure to ground the casing of the burner to an Earth of less than 100Ω.
- (9) Don't bundle the power cable and high-voltage cable of the ignition transformer together with the flame detector cable or connect them through the same conduit together, but separate them from each other. Connect high-voltage cables independently, in particular, and keep them apart from the protectorelay by 10cm at least.
- (10) Connect the high-voltage cable to the ignition transformer securely without any poor contact. If there is a poor contact, radio-frequency waves may be generated to cause TV/radio interferences and wrong operations. Mount the ignition transformer directly onto the burner or a metal portion electrically connected to the burner.
- (11) After wiring, check if the protectorelay has been connected properly. A wrong connection, if any, may cause a damage failure or a wrong operation.

1. Mounting Direction

This protectorelay is mounted so that the cover mounting screws are vertically aligned with each other usually as shown in Fig. 1. However, it can be mounted in an optional direction so long as the reset button of the safety switch does not face downward.

2. Method of Mounting and Dismounting the Protectorelay and Subbase

- (1) Loosen two upper and lower cover mounting screws shown in Fig. 1, and bring the cover mounting hooks to the outside of the protectorelay as shown by a dotted line.
- (2) Hold the subbase and cover by hands, and separate them left and right. Be careful not to apply any excessive force, otherwise they may be broken.
- (3) For mounting them, reverse the above procedure.

3. Method of Mounting the Subbase

- (1) Prepare knockout holes shown in Fig. 1 and Fig. 2 as required, and mount a wiring conduit.
- (2) Fix the subbase at the specified position by using screws.

4. Wiring Method to Subbase

- (1) Fig. 2 shows the terminal mounting layout of the subbase. Fig. 3 shows a connection example to an external unit.
- (2) Connect the voltage side (H) of the power supply to terminal ①, and connect the grounding side (G) of the power supply to terminal ②. For the connection to the valve, see Fig. 4.
- (3) Don't connect cables to interfere with the installation of the protectorelay which is mounted by a plug-in method.
- (4) After confirming that the subbase has been connected correctly, plug the protectorelay onto the subbase, and fix it by cover mounting screws.
- (5) Connect terminal ② and ground as shown in Fig. 7 (1), (2) when a surge absorber is used. The surge absorber mounting bracket is internally pressurized with the grounding side to be conductive. Accordingly, it is connected to a ground simply by mounting it to a grounded boiler housing or the like. Connect a lead wire of larger than 0.75mm^2 (wire diameter: 0.18mm , No. of wires: 30) specified in JIS C3306 to the power supply. Mount a #187 faston plug socket at one end, and shorten the connection cable as much as possible.

5. Replacing R8398D with R4750C

- (1) Remove R8398D from the subbase.
- (2) Check if the connection is done to the subbase by (1) or (2) in Fig. 8, and reconnect R4750C as shown in (2), if the present connection is as shown in (1). Connection (2) is employable as it is. The surge absorber is used in the same way as described in 4 (5).
- (3) Plug R4750C into the subbase, and fix it by cover mounting screws. Now, this exchange work ends.

A Wiring Example to an External Unit

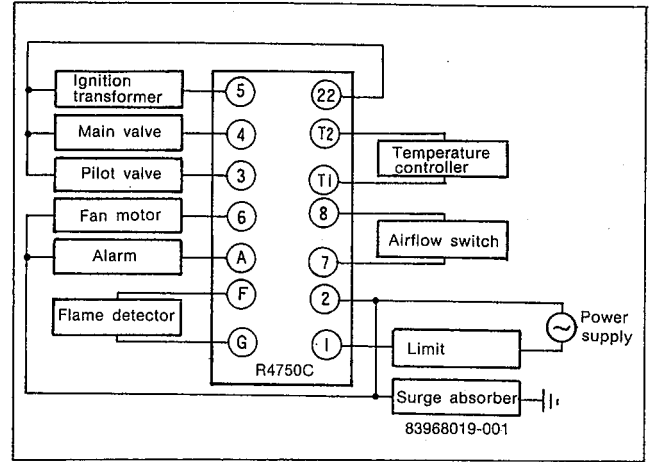


Fig. 3

Connection to Power Supply and Valve (When the power supply has both voltage side and grounding side)

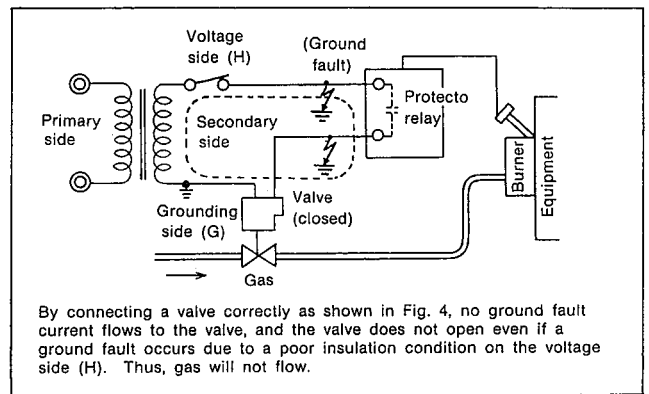


Fig. 4

Connection Method to Subbase

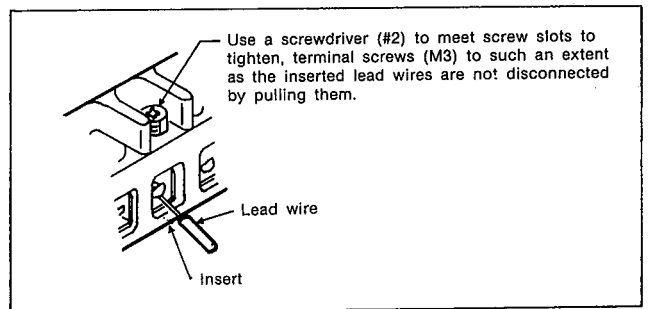


Fig. 5

External Dimensions to Surge Absorber

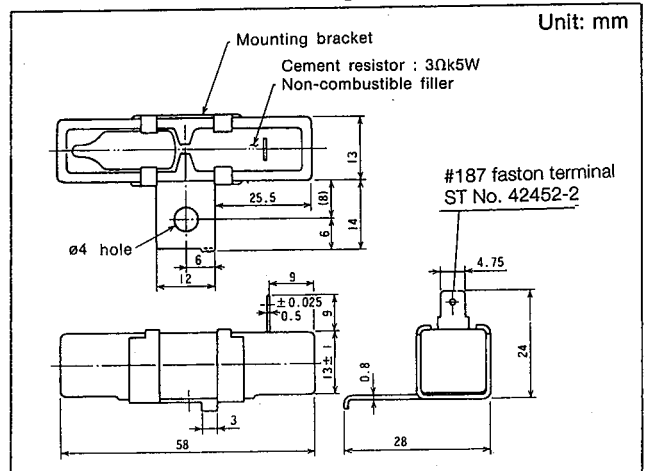


Fig. 6

Safety Measure for Power Polarity

This protectorelay is provided with a built-in ground fault detection circuit. Accordingly, if a ground fault, occurred due to an insulation failure of the ignition transformer, pilot valve, main valve, or other loads, the ground fault detection circuit detects the ground fault to shut off and lock out this protectorelay even if the power supply is provided with neither voltage side nor ground side.

Connection of Surge Absorber

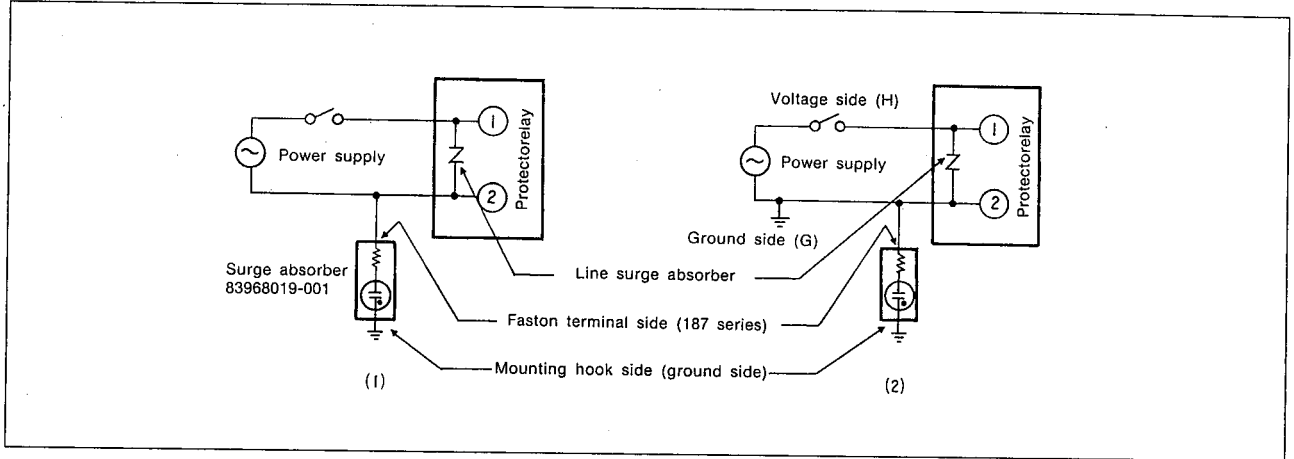


Fig. 7

Reconnection Method (when R8398D subbase is used)

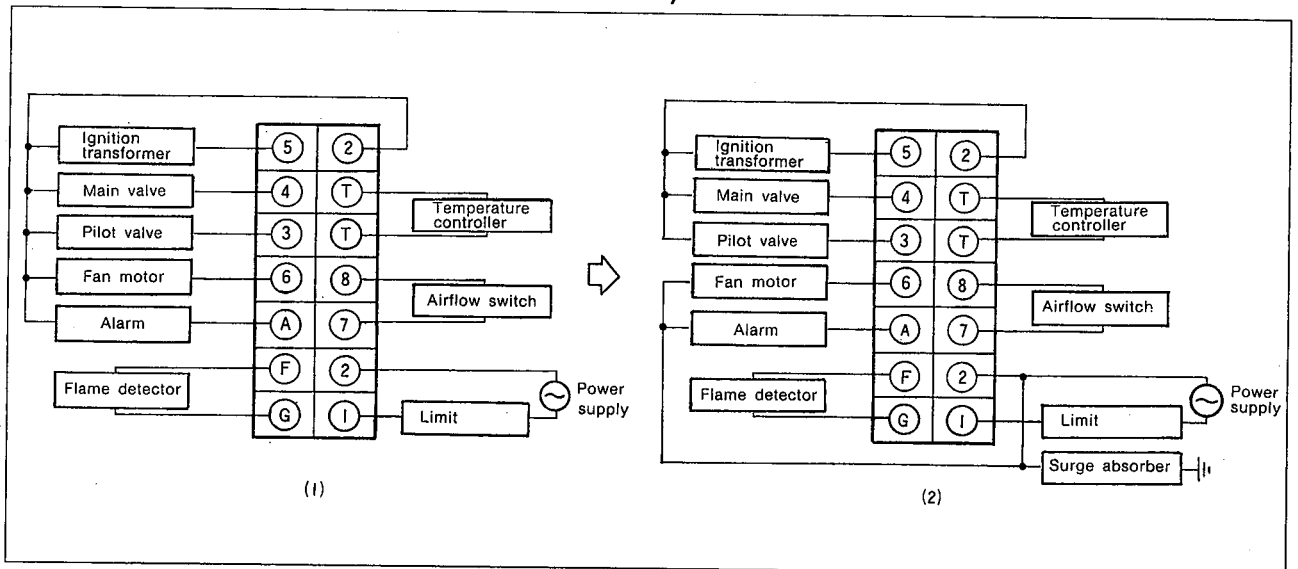


Fig. 8

Connection Example to an External Unit/Internal Block Diagram

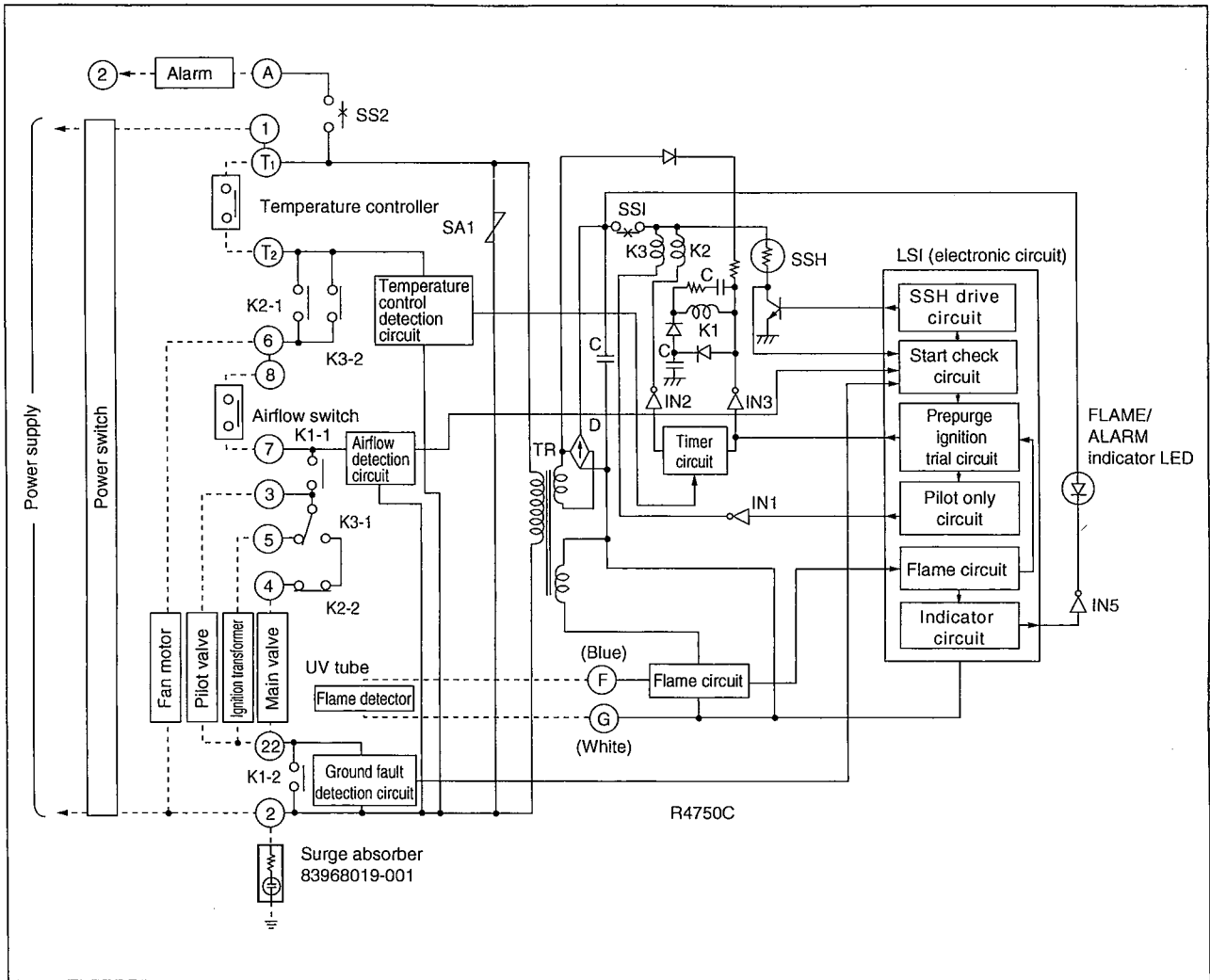


Fig. 9

1. Normal Operation (See Fig. 9 and Fig. 10)

Power switch and each controller	R4750C operation	Protectorelay conditions
Turn on the power switch.	Power voltage is applied across terminals ①, ② and also across terminals ①①, ②②.	
Turn on the temperature controller.	Simultaneously when temperature controller is turned on, relay K2 is energized. Contact K2-1 closes, while contact K2-2 opens.	Fan motor starts.
	Simultaneously when the airflow switch is turned on, it is confirmed that SSH is not broken by the LSI start check circuit. Then, the prepurge ignition trial circuit operates to start counting the prepurge timing.	Airflow switch turns on.
	After the end of prepurge timing, relay K1 is energized. Contact K1-1 closes and also contact K1-2 closes.	Ignition transformer operation is started. Pilot valve opens.
	If the flame detector detects a flame within the ignition trial timing (4±1sec), relay K3 is energized in 5±1 seconds (spark timing) after the ignition trial has been started. Contact K3-1 is reversed to terminal (4). Contact K3-2 closes.	FLAME/ALARM indicator LED light. Ignition transformer stops operating.
	After pilot only timing, relay K2 is deenergized. Contact K2-1 opens, while contact K2-2 closes.	Main valve opens.
Turn off the power switch or temperature controller.	Relays K1 and K3 are deenergized, contact K1-1 opens, contact K1-2 opens, and contact K3-1 is reversed to terminal ⑤.	Fan motor stops. Pilot valve closes. Main valve closes. FLAME/ALARM indicator LED goes out.
	All circuits are reset to the first state to be ready for the next ON signal.	Airflow switch is turned off.

2. Ignition Failure (No ignition) (See Fig. 11)

If the flame detector does not detect any flame within the ignition trial timing after the ignition transformer operation has been started in the condition of equipment" column of the above "normal operation" table and the pilot valve has been opened, the ignition operation stops, and the pilot valve closes. (Relay K1 is deenergized, contact K1-1 opens, and contact K1-2 opens) The LSI SSH control circuit and indicator circuit operate to flicker the FLAME/ALARM indicator LED. After the lockout timing, the equipment is locked out. As a result, contact SS2 closes (SS1 opens) to issue an alarm. In this case, both indicator LED flickering and alarm are continued until they are reset. For restarting the system, reset it by pushing the reset button.

3. Abnormal Flame Failure during Combustion (See Fig. 12)

If a flame failure occurs during normal combustion after the ignition transformer stops operating in the condition of equipment" column of the above normal operation table and the main valve has been opened, the pilot valve and main valve close after the end of flame response timing. (Relay K1 and K3 are deenergized, contact K1-1 opens, contact K1-2 opens, and contact K3-1 is reversed to terminal ④. Also, relay K2 is energized. Contact K2-1 closes, and the fan motor circuit is held.) The LSI SSH control circuit and indicator circuit are operated to flicker the FLAME/ALARM indicator LED. The equipment is locked out after lockout timing. The subsequent operation is the same as described in para. 2 "ignition failure".

4. Operation when a False Flame Signal is Generated

(1) When a false flame signal is continued from the start time; (See Fig. 13 (1))

Simultaneously when the temperature controller turns on, relay K2 is energized (contact K2-1 closes, and contact K2-2 opens), and the fan motor starts opening. After the airflow switch has been turned on, the LSI frame circuit, indicator circuit, and SSH control circuit operate, and the FLAME/ALARM indicator LED flickers.

The equipment is locked out after lockout timing. Subsequent operation is as described in para. 2 "ignition failure".

Normal Operation

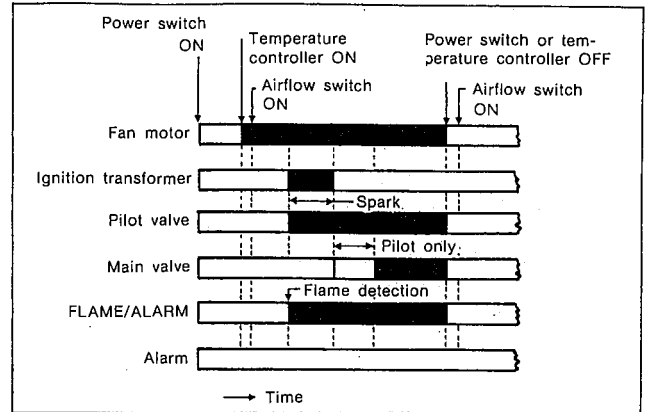


Fig. 10

Ignition Failure (No ignition)

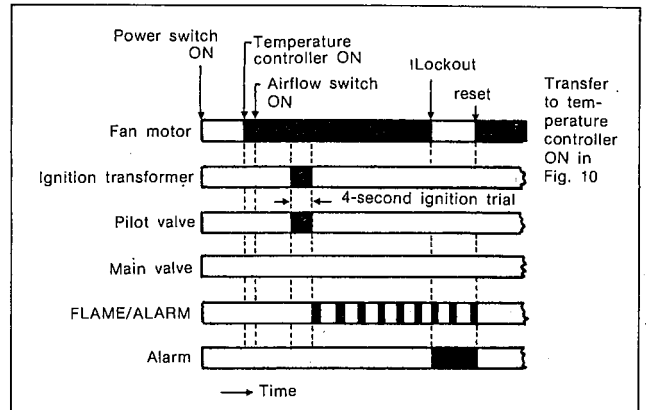


Fig. 11

Abnormal Flame Failure during Combustion

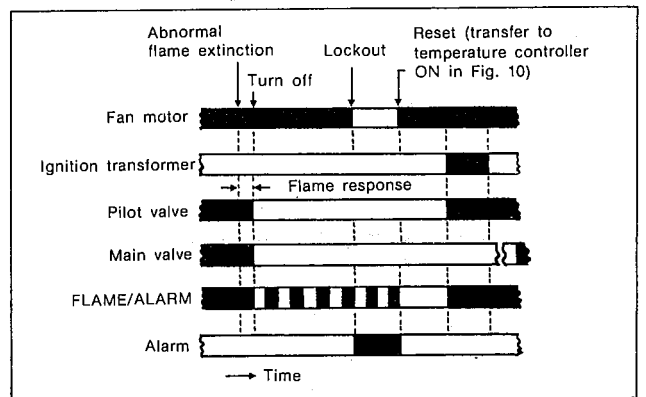


Fig. 12

Operation in Case of a False Flame Signal

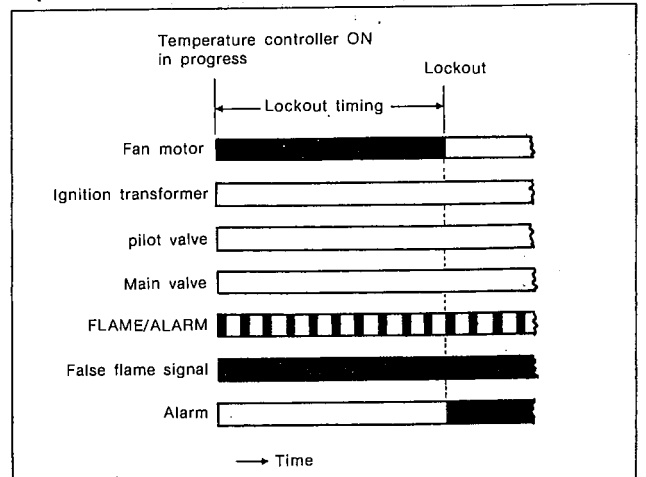


Fig. 13 (1)

- (2) When a false flame signal is existed from the start time, and it goes out during prepurge timing; (See Fig. 13 (2))

The FLAME/ALARM indicator LED goes off flickering, then the R4750C shifts to normal operation (prepurge operation).

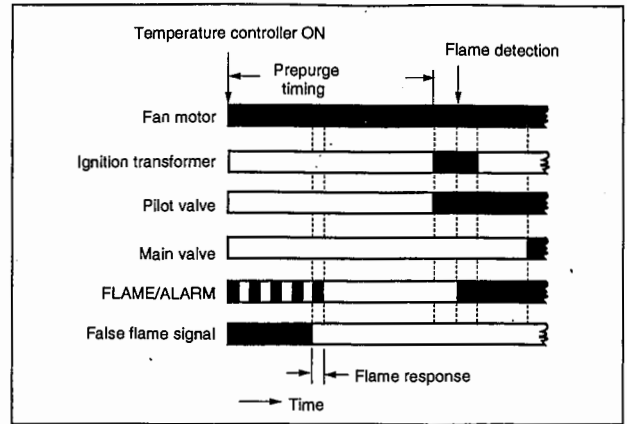


Fig. 13 (2)

- (3) When a false flame signal is generated halfway in the course of prepurge; (See Fig. 13 (3))

Simultaneously when the false flame signal is generated, the FLAME/ALARM indicator LED flickers, and the equipment is locked out after lockout timing. FLAME/ALARM indicator LED continues flickering.

Operation during the Generation of a False Flame Signal

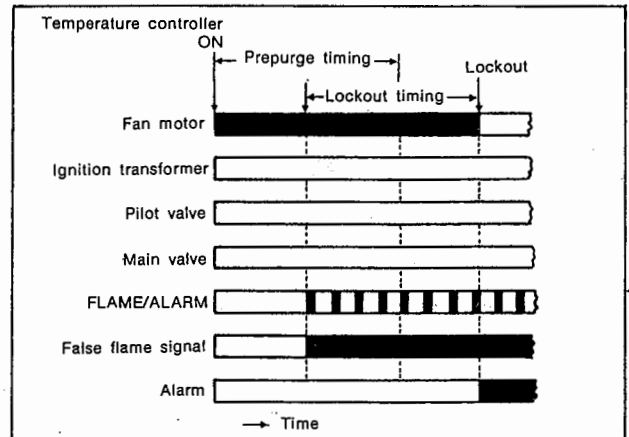


Fig. 13 (3)

- (4) When a false flame signal occurs during prepurge timing, and it goes out during prepurge timing; (See Fig. 13 (4))

Though the FLAME/ALARM indicator LED flickers during the false flame signal is existed, the R4750C shifts to normal operation after the false flame signal disappears.

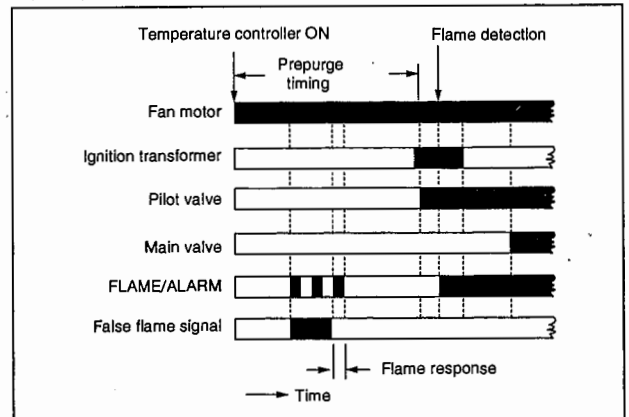


Fig. 13 (4)

5. Operation when a Ground Fault was Detected (See Fig. 14)

A ground fault is detected in all time zone from turning on the power supply to turning on the airflow switch. If the ground fault detection circuit detects a ground fault within this time zone, LSI indicator circuit and SSH control circuit operate to flicker the FLAME/ALARM indicator LED.

The equipment is locked out after lockout timing. Subsequent operation is the same as described in para. 2 "ignition failure".

If the temperature controller turns on in this time zone, relay K2 is energized (contact K2-1 closes, while contact K2-2 opens), and the fan motor starts operating. However, the sequence does not advance, and the fan motor stops after lockout timing.

Operation when a Ground Fault is Detected

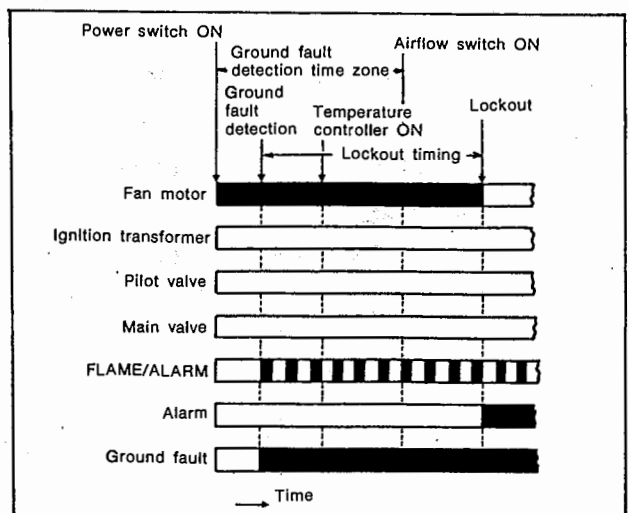


Fig. 14

Caution

If a lockout occurs, it shows the entire system is in trouble. Locate and eliminate its cause carefully.

5. INSPECTION AND ADJUSTMENT

Caution:

Particularly be careful since power voltage is applied to almost all terminals during check and adjustment. Turn off the power supply in advance when connecting or disconnecting cables.

1. Preliminary Inspection

Check the following items.

- (1) Check if the ambient temperature and humidity are within allowable ranges.
- (2) Check if all connections are normal without any looseness of each terminal screw.
- (3) Check if the flame detector is mounted correctly. (For the mounting position, direction, etc., refer to the instruction manual for the flame detector.)
- (4) Check if the burner is adjusted correctly.
- (5) Check if the combustion air intake and exhaust cylinder outlet are free of obstacles and shields.
- (6) Check if the power voltage and frequency are the same as indicated on the protectorelay.
- (7) Check if the safety switch of the protectorelay is reset. (Push the red reset button on the front panel.)

2. Inspection Procedure

Check and adjust the following items sufficiently for operating the combustion equipment safely.

(1) Flame current check

Checking the flame current is the best method to judge whether the mounting position of the flame detector is suitable or not. Check the flame current when installing the flame detector and during subsequent service. It is possible to prevent a shutoff failure due to the shortage of the flame current by conducting this check once every once at least.

Insert the current measurement plug of an Analog flame meter FSP136A100 into the test jack on the front panel of R4750C. (The jack cover can be detached by lightly wrenching it by means of finger nails. Reset the jack cover as before after the end of checking the flame current.)

Measuring method of flame current

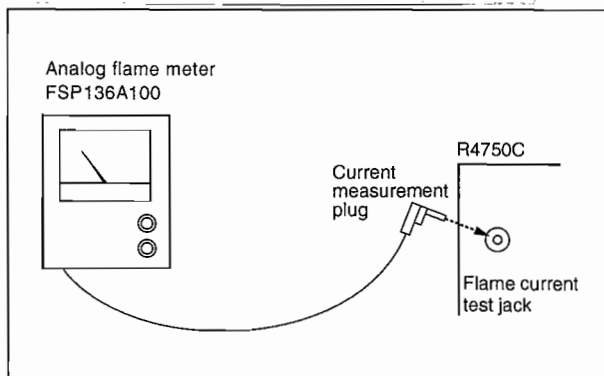


Fig. 15

Then, operate the burner, and read the flame current. The current value shall be $4\mu\text{A}$ at least and stable. Make sure that the meter deflection does not change more than necessary. If a stable current value is not obtainable, it may be caused by one or more items shown below. Check these items sufficiently.

- ① Power voltage or frequency is not suitable.
- ② Feed gas pressure or air-to-fuel ratio is not suitable.
- ③ The flame detector is not properly.
 - Open condition
 - Short-circuit condition
 - High-resistance short-circuit of lead wires due to humidity and dirt
- ④ Mounting failure in the flame monitoring direction
- ⑤ Contamination on light receiving face
- ⑥ Deterioration of UV tube (ultraviolet photoelectric tube)

(2) Pilot turndown test

This test is done for determining the minimum pilot flame size which can securely ignite the main burner when the ignition is done in the sequence of detecting the pilot burner flame, opening the main valve, and igniting the main burner. Measure the flame current to make sure that it exceeds $4\mu\text{A}$ before and after this test.

- ① Stop all units by turning off the power switch.
- ② Shut off the gas to the main burner by closing the main valve (by disconnecting one side of the connection to the main valve or by closing its manual cock by hand). Keep the pilot valve as it is.
- ③ Turn on the power switch. When the temperature controller turns on, the pilot valve opens and the ignition operation is started simultaneously concurrently after prepurge.
- ④ After starting the combustion of the pilot burner, throttle the pilot valve (manual cock) until the protectorelay is shut off due to the flame extinction. At the flame extinction shutoff time, mark the position on the manual cock. Reset the safety switch by pushing the reset button, and restart the operation. Reset the manual cock to the position slightly before the marked position (in the direction of higher gas flow).
- ⑤ Open the power switch, reset the main valve to normal condition, and close the power switch again. After prepurge, the pilot burner starts combustion. If the main burner does not ignite, open the power switch at once. This failure is caused by a small pilot flame, and the pilot flame must be enlarged. Correct the mounting position by moving the monitoring angle of the flame detector slightly outward from the center axis of the pilot flame.
- ⑥ After correcting the mounting position of the flame detector, repeat steps ① to ⑤, and check if the main burner securely ignites.

Caution:

If it is necessary to repeat this test, stop the entire system and completely purge unburnt gas from the inside of the combustion chamber and exhaust cylinder for the purpose of preventing an explosive accident.

(3) Safe shutoff check**① Limit operation check**

If the boiler or furnace is simulatedly operated by lowering its limit switch setting during the burner operation, a safe shutoff operation will occur. After confirming the safe shutoff, reset the limit switch to the initial setting. The burner will be started again.

② Flame cutoff check

Close the manual gas cock during burner operation. After the flame response timing, the pilot valve and main valve are closed, and the system is locked out after the lockout timing. After confirming this operation, open the manual cock. Reset the system by pushing the reset switch after the safety switch has been cooled down. The burner is restarted.

③ Power failure (power interruption) check

Stop the combustion by opening the power switch during burner operation, and close the power switch after a while. The burner will be restarted.

6. MAINTENANCE AND INSPECTION

! Warning

Electrical shock hazard! Do not touch terminal F and the signal cable of the flame detector connected to the terminal F.

Failure to pay attention to this warning might cause electric shock, because of an electric charge that still remains at the terminal F and the connected signal cable even after turning the power OFF.

1. General Maintenance and Inspections

- (1) Carry out all inspections and adjustment including the cautions on page 1 when replacing R4750C.
- (2) Never lubricate any part of R4750C.
- (3) Remove combustion products from the burner.

2. Maintenance and Inspection Frequency

Determine the maintenance and inspection frequency by taking the type of the equipment, ambient conditions at the installation place, working frequency, and other circumstances into due consideration. The reference frequencies are as described below.

- (1) Clean the burner once every year at least.
Perform pilot turndown test after cleaning.
- (2) Check the burner flame extinction shutoff once every month at least.
- (3) Check the flame current once every month at least.

3. Trouble Check

Observe the following procedure when checking causes of a trouble.

- (1) Open the power switch.
- (2) Reset the safety switch by pushing the RESET button of the protectorelay.
- (3) Close the power switch. Check if the specified voltage is applied across terminals ① and ②.
- (4) If this voltage is zero, check the limit switch contact, fuse, power switch, feed power supply, and other components.
- (5) Set the protectorelay so that the temperature controller turns on. A voltage is applied across terminals ⑥ and ② to start the fan motor. Proceed to step ⑦.
- (6) If the fan motor does not start operating, check if the voltage is applied across terminals ⑥ and ②.
 - ① If the voltage is detected, check the fan motor and the connection to the fan motor.

- ② If no voltage is detected, check the controller.

- (7) Make sure that the airflow switch functions normally.

- ① When the airflow switch functions normally, relay K1 operates, and the ignition action is started after prepurge timing.

- ② If the airflow switch does not function, adjust it to turn it on. If not turned on, the airflow switch is defective. Replace it.

- (8) If the pilot burner does not ignite, check if a voltage is applied across terminals ③ and ②② and also across terminals ⑤ and ②②.

- ① When the voltage is detected, check the connection from the pilot valve to terminals ③, ②②, and also the connection from the ignition transformer and terminals ⑤, ②②.

- ② If the voltage is not detected, R4750C is defective. Replace it.

- (9) Flame detector function test
After the pilot burner has ignited, make sure that the flame current exceeds 4 μ A.

- (10) Sequence operation check
After the pilot burner has ignited, check the main valve operation. If the main valve is not open, check if a voltage is applied across terminals ④ and ②② after pilot only timing.

- ① Check the connection between the main valve and terminals ④, ②②, if the voltage is detected.

- ② Replace R4750C, if no voltage appears.

- (11) After the pilot burner has ignited, make sure that the ignition action of the ignition transformer stops. If it does not stop, check the connection between the ignition transformer and terminals ⑤, ②②. If the connection is correct and the ignition action does not stop, R4750C is defective. Replace it.

- (12) If a false flame signal is generated at the start time, the fan motor starts after the temperature controller has been turned on. The FLAME/ALARM indicator LED flickers and the system

is locked out after about 30 seconds and also an alarm is issued. In such a case, observe the following procedure.

ing the connection from terminal ②, the cause is other than a ground fault of the safety shutoff valve or ignition transformer.

- ① Check the safety shutoff valve and ignition transformer for a ground fault. If FLAME/ALARM indicator LED flickers after disconnect-

7. SPECIFICATIONS

Application	Batch operation of oil-fired or gas-fired combustion equipment having a maximum combustion rate of 580kW						
Model	Rated power supply	Allowable power voltage	Combined flame detector		FLAME/ALARM indicator LED		Frame current
R4750C1007	AC100V, 50-60Hz	85 to 110% of the rated voltage	Small ultra-vision C7027A C7035A		Lights: During normal combustion Flickers: Ignition failure Abnormal flame failure Ground fault detection Generation of false flame signal at the start time		Higher than 4μA Ignition detection sensitivity: 1.2μA max. Flame extinction detection sensitivity: 0.3μA min.
R4750C1015	AC200V, 50-60Hz						
R4750C1023	AC100V, 50-60Hz						
R4750C1031	AC200V, 50-60Hz						
R4750C1049	AC100V, 50-60Hz						
R4750C1056	AC200V, 50-60Hz						
Timing sequence (at normal temperature, normal humidity and rated voltage)	Model	Prepurge	Ignition trial	Spark	Pilot only	Lockout	Frame response
	R4750C1007	2.5±1.5s	4±1s	5±1s	7.5±2.5s	Shorter than 30s	1.5±0.5s (At frame current 5.5μA)
	R4750C1015						
	R4750C1023	33±6s					
	R4750C1031						
	R4750C1049	40+20s -5s					
R4750C1056							
Flame extinction sequence	Non-recycle						
False signal generation time	Lockout						
Control load Cotact rating	Terminal	5	3	4 Note (1)	6	A	In case of note (1): 400VA during opening operation 200VA when the opening is held
	Load	Ignition transformer	Pilot valve	Main valve	Fan motor	Alarm	
	Contact capacity	250VA	200VA	200VA	200VA	75VA	
Ground fault detection resistance	Higher than 10KΩ (at normal temperature, normal humidity, and rated voltage)						
Inductive lightning surge resistance	10kV, 1.2/50μs (JEC-212, Surge impedance : Higher than 75Ω) Mount a surge absorber between one side (terminal ②) of power supply and ground. Note (2)						
Power consumption	Lower than 9W+25%						
Insulation resistance	Higher than 50MΩ between each terminal excluding terminals (F), (G) and ground, by using a 500V DC megger						
Dielectric strength	1500V AC, 1min or 1800V AC, 1s between each terminal excluding terminals (F), (G) and ground						
Allowable ambient temperature	-20 to +60°C	Cover color		Light grey			
Allowable storage temperature	-25 to +70°C	Mass		0.73kg			
Allowable ambient humidity	Lower than 90% RH at 40°C	Standard accessory		Subbase			
Vibration resistance	10 to 55Hz, 1min, 0.75mm (in X, Y, Z directions, 2h each)	Installation		Fix the subbase by screws, and plug the protorelay into the subbase			
Impact resistance	294m/s ² (durability)	Mounting position		Optional, except that the reset button faces downward.			
Auxiliary devices and parts (option)	Surge absorber: Model number 83968019-001 Analog flame meter: FSP136A100						
Standard and extension distance of flame signal wire	Standard: 600V vinyl insulated wire 2.0mm ² (abbreviation: IV wire) Extension distance: About 200m Caution: Separate the flame signal wire from ignition high-voltage wire and drive power wire through a separate conduit.						

Note (2) Surge absorber

Model	83968019-001
Discharge start voltage	1500V±300V
Initial insulation resistance	Higher than 50MΩ by 500V DC megger
Insulation resistance after life deterioration	Higher than 1MΩ by 500V DC megger
Allowable ambient temperature	-20 to +60°C
Allowable ambient humidity	Lower than 90% RH at 40°C

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Specifications are subject to change without notice.

Yamatake Corporation
Advanced Automation Company

1-12-2 Kawana, Fujisawa
Kanagawa 251-8522 Japan

URL: <http://www.azbil.com>

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