

FRS100 Multiburner Control User's Manual



Thank you for purchasing the FRS100 Multiburner Control.

This manual contains information for ensuring the correct use of the FRS100. 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 FRS100. 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.

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). Do not use for continuous burner operation (nonstop combustion for 24h or longer).



This device does not have the prepurge and ignition sequencing functions required for burner ignition. Use this device as part of a system whose design gives careful consideration to the prepurge timer and sequence timing, following established safety guidelines.



Wire terminals 1 and 2 so that they receive power continuously whenever the power switch is turned on. This is absolutely necessary to ensure operation of the self-check circuits at startup. Therefore, do not wire a thermostat between the power switch and terminal 1 or 2. Doing so might cause a serious combustion equipment accident.



Connect loads (ignition transformer, solenoid valve, etc.) directly to the output terminals of this device. If they are not directly connected, combustion safety cannot be ensured.



Do not allow the pilot or main burner "Safety Time" (ignition trial time) to exceed the specifications of the burner or equipment manufacturer. If they do, fuel may accumulate in the combustion chamber and form an explosive air-fuel mixture, resulting in a serious explosion hazard.



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 high voltage 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.



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.



Carry out the pilot turndown test carefully. If the flame detector is set so that it detects a pilot flame that is too small to ignite the main burner, this device will not be able to detect a flame failure in the main burner. In that case, fuel will continue to be supplied, causing a serious explosion hazard.



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

WARNING



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.



To prevent electric shock, turn the power off and discharge terminals F and G before removing this device from the subbase. Use lead wires to connect terminals F and G of the flame simulator (FSP300C100) to terminals F and G of this device for 10 seconds or more.

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



If timers and auxiliary relays are needed for additional functions, select ones with high reliability, and be sure to design the circuit correctly.



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



Make sure the flame detector does not detect ultraviolet rays other than those of the burner flame. If the flame detector responds to other ultraviolet rays, it will report that there is a flame even if the burner flame goes out. As a result, fuel will continue to be discharged, causing a very serious explosion hazard.

CAUTION



Follow all applicable regulations when doing the wiring work.



Connect the blue signal lead from the Minipeeper Ultraviolet Flame Detector to terminal 5 and the white lead to terminal 6. Turning on the power when the flame detector is incorrectly wired could damage the UV tube.



Run the high-voltage ignition transformer cable separately and keep it at least 10 cm away from this device.



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.



Keep power lines and ignition transformer high-voltage cables separate from the flame detector wires.



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.



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 .



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



Make sure that the flame detector does not detect the ignition spark. If the flame detector can detect the spark, change the detector's line of sight or change the ignition electrode's position.



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



This product 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.

CAUTION



If the safety shutoff has been activated, check all of the items on the checklists in Chapter 3, **ADJUSTMENTS FOR TRIAL OPERATION** before restarting the equipment.



Check the flame current at least once per month. Doing so can prevent shutdowns caused by a weak flame current signal.



This device has an operating life. Assuming that the operating life of the combustion equipment used with this device is longer, be sure to do periodic maintenance and replacement of this device.



In the event that this device is replaced, do all of the checks listed in Chapter 3, **ADJUSTMENTS FOR TRIAL OPERATION**.



When doing a maintenance inspection of the burner, be sure to do the pilot turndown test. Inspection must be done at least once a year.



Conduct periodic inspections in accordance with the user's manual of the equipment manufacturer.



When cleaning the burner, clean the flame detector as well.



Do not transport this device while it is mounted on a DIN rail. Remove it from the subbase and pack it in its original box. If it is transported while on a DIN rail, it might fall off and be damaged.

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 FRS100.

 **Note:**

Notes indicate information that might benefit the user.

(1), (2), (3):

Numbers within parentheses indicate steps in a sequence or parts of an explanation.

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SAFETY PRECAUTIONS **Conventions Used in This Manual**

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Chapter 1. OVERVIEW AND PRODUCT CONFIGURATION

■ Overview

The FRS100 Multiburner Control is a combustion safety control with a safe-start circuit, for use with manually ignited combustion equipment. To ensure safety, the FRS100 prevents ignition if anything abnormal is detected at start up, and shuts off the fuel valve if a flame failure occurs during operation. It is used in conjunction with an ultraviolet flame detector or flame rod for batch operation of a burner. For continuous burner operation (nonstop combustion for 24h or longer), instead of the FRS100, use the AUR350C, which has a continuous self-checking function.

Because the FRS100 does not have an ignition function, it is used for systems in which an operator ignites the burner manually. This device should be used in combination with external instrumentation that supplies a purge function.

Key Characteristics of the FRS100

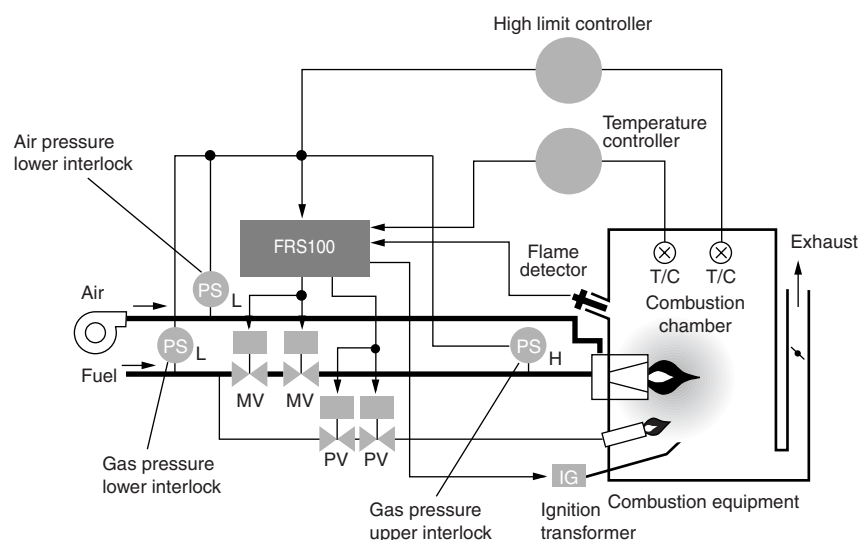
Compatible burner operation type	Purge function	Ignition function	Flame monitoring	Behavior if flame failure occurs	Compatible flame detectors
Batch	No	No	Yes	Does not recycle	<ul style="list-style-type: none"> • Ultraviolet sensor • Flame rod

■ Features

- Upon equipment startup, the FRS100 checks both itself and the flame detector. If anything abnormal is detected, the FRS100 prevents ignition to ensure safety.
- The FRS100 is designed to be compact, and can be plugged into the wiring sub-base. The sub-base can be mounted by screws or onto a DIN rail.
- The power supply state and ignition detection can be verified easily from the LEDs on the front display. Completion of the start check is indicated by the LED on the center of the body behind the front cover.
- Flame voltage output (0 to 5Vdc) can be checked by the FSP136A100, or continuously monitored by a panel meter or recorder.
- The FRS100 has a dedicated connector so that the optional FRS60A Flame Meter can be attached.

■ System configuration

In terms of the overall system, the FRS100 serves as the flame monitoring device. It is used as shown in the diagram below.



■ Security function

The FRS100 is designed to ensure safety, and plays an important safety role by monitoring the burner operation and the flame.

1. Combustion monitoring and safety shutoff
 - Detects flame failure in the burner and quickly shuts off the fuel and shuts down the burner.
 - When an ignition failure, flame failure or flame-out occurs, the FRS100 follows a fixed sequence in shutting down each piece of equipment.
2. Startup, operation, and shutoff of combustion equipment
 - The FRS100 operates each device according to a predetermined sequence and timing.
3. Safe startup
 - At every startup signal, the FRS100 checks for false flame in the flame detector and flame detection circuit.
 - If a problem is detected, the FRS100 does not start the burner.
4. Redundant design
 - Maintains safety even if its own self-check circuit fails.
 - Will not deviate from the proper ignition sequence.

■ Precautions for facility instrumentation

In designing facilities that use combustion safety devices, be sure to give careful consideration to the safety guidelines listed below.

- For safety standards for industrial facilities using combustion equipment, see the technical guidelines published by the Ministry of Health, Labour and Welfare
- For general safety rules for industrial combustion furnaces, see JIS B 8415.
- For technical safety guidelines for gas combustion furnaces in industrial use, see publications by the Japan Gas Association.

● Important points for ensuring safety

1. Connect the load directly to the FRS100.
2. Design the interlock so that it can directly cut off power to the load.
3. Be sure to use a safe startup circuit upon startup.
4. Do not set up a bypass, such as manual operation, for any load.
5. Have a redundant main valve and pilot valve.

● Precautions for system design

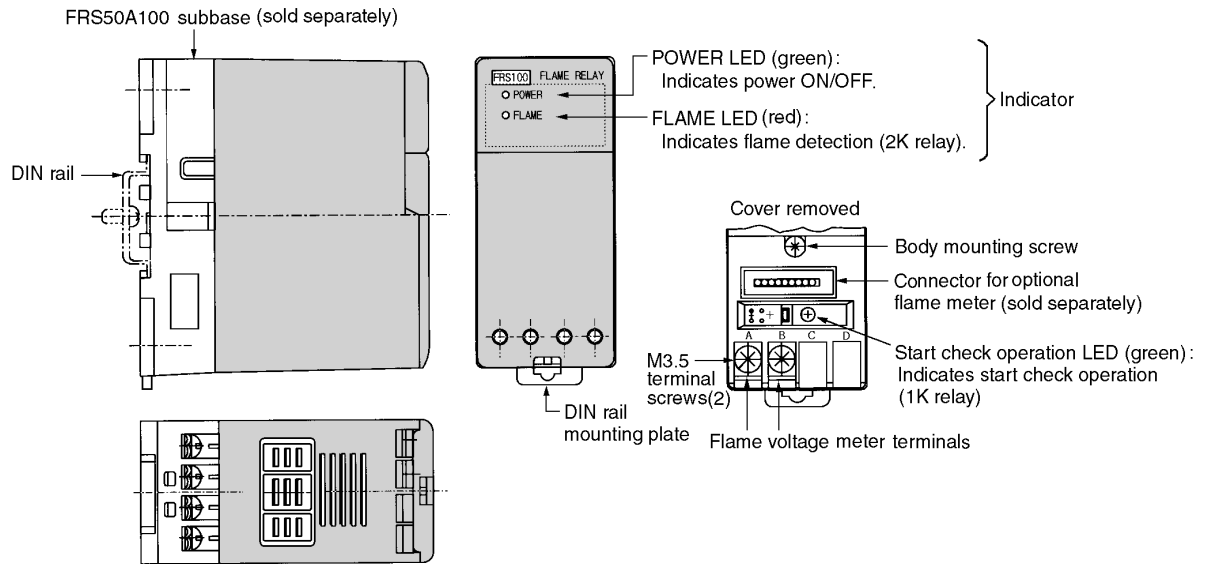
Since the FRS100 does not have purge or ignition functions, they must be provided externally.

■ Model selection guide

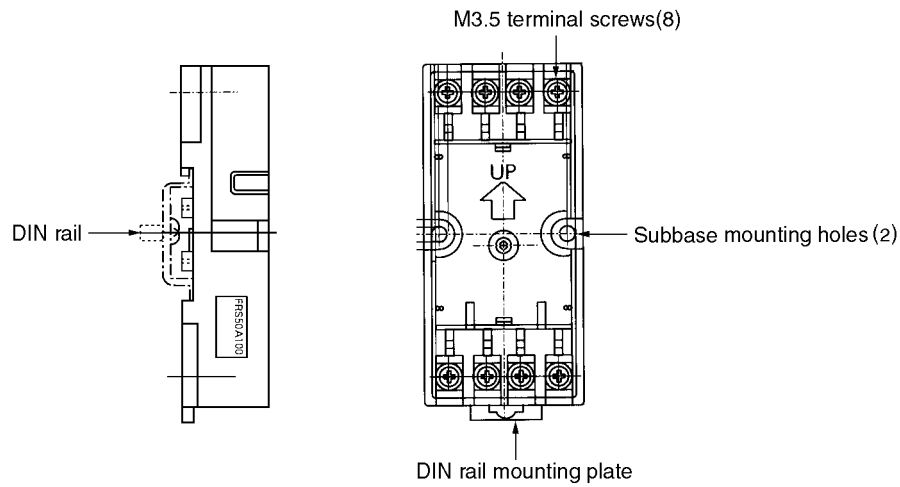
Model	Model No.	Rated power supply	Power consumption	Flame failure response	Flame detector		
Standard model	FRS100B100	100Vac 50 / 60Hz	3W max.	3 ±1s (flame voltage 2V)	Flame Rod C7007A, C7008A		
	FRS100B200	200Vac 50 / 60Hz		2s max. (flame voltage 2V)		Ultraviolet Flame Detector C7012A, C7012C	
	FRS100B104	100Vac 50 / 60Hz			7W max.		3 ±1s (flame voltage 4.2V)
	FRS100B204	200Vac 50 / 60Hz		2s max. (flame voltage 4.2V)			
	FRS100C100	100Vac 50 / 60Hz	7W max.			3 ±1s (flame voltage 3.5V)	
	FRS100C200	200Vac 50 / 60Hz		2s max. (flame voltage 3.5V)			
	FRS100C104	100Vac 50 / 60Hz			2s max. (flame voltage 3.5V)		
	FRS100C204	200Vac 50 / 60Hz					
High-sensitivity model	FRS100C150	100Vac 50 / 60Hz	7W max.	3 ±1s (flame voltage 3.5V)			
	FRS100C250	200Vac 50 / 60Hz				2s max. (flame voltage 3.5V)	
	FRS100C154	100Vac 50 / 60Hz		2s max. (flame voltage 3.5V)			
	FRS100C254	200Vac 50 / 60Hz					

■ Names of parts

● FRS100 body



● FRS50A100 subbase (sold separately)



■ Configuration

● Flame Detector

FRS100B

Name	Model No.
Ultraviolet Flame Detector	C7012A/C
Flame Rod	C7007A, C7008A

FRS100C

Name	Model No.
Minipeeper Ultraviolet Flame Detector	C7035A, C7027A

● Optional Parts (sold separately)

Name	Model No.	Name	Model No.
Subbase	FRS50A100	Flame Meter	RS60A
Flame simulator for C7035A, C7027A	FSP300	Flame Simulator for Flame Rod	123514A, 121708
Lightning surge absorber	83968019-001		

Chapter 2. MOUNTING AND WIRING

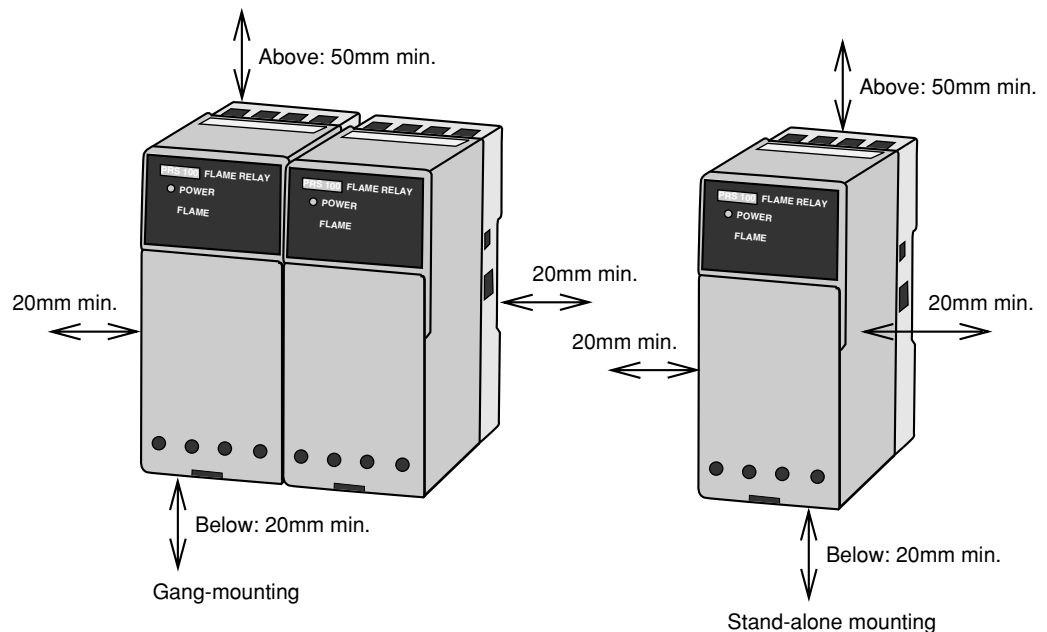
2 - 1 Mounting and Wiring the Subbase

⚠ 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
- ⊘ Do not transport this device while it is mounted on a DIN rail. Remove it from the subbase and pack it in its original box. If it is transported while on a DIN rail, it might fall off and be damaged.
- ! When installing and wiring, be sure to follow the instructions in this manual and in the user's manual for the combustion equipment.

● Mounting location

Maintain space around the control as shown below for heat radiation, and to facilitate mounting, removal, wiring and maintenance.



! Handling Precautions

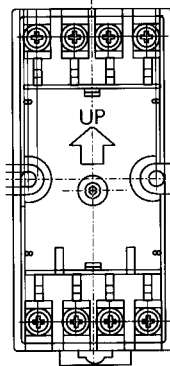
- If there is room, leave as much space as possible between the FRS and other FRS units to allow for heat radiation.
- If ambient temperature is close to the allowable upper limit, reduce the internal temperature of the control panel by mounting a panel cooler or a cooling fan.

Allowable ambient temperature upper limits

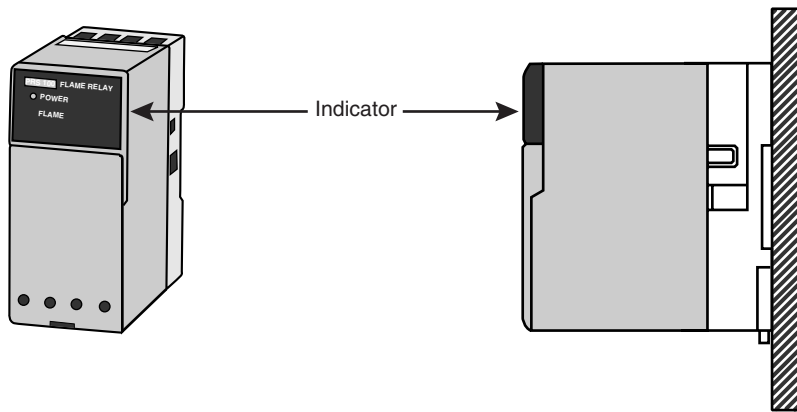
- Gang-mounting: 45°C
- Stand-alone mounting: 60°C

● **Mounting direction**

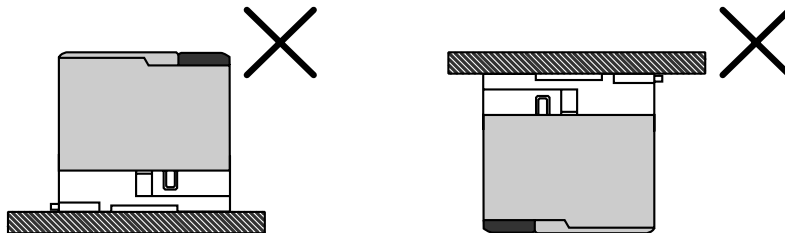
- Mount a vertical plane so that the arrow on the subbase is facing upwards.



- Mount so that the display panel is upward.

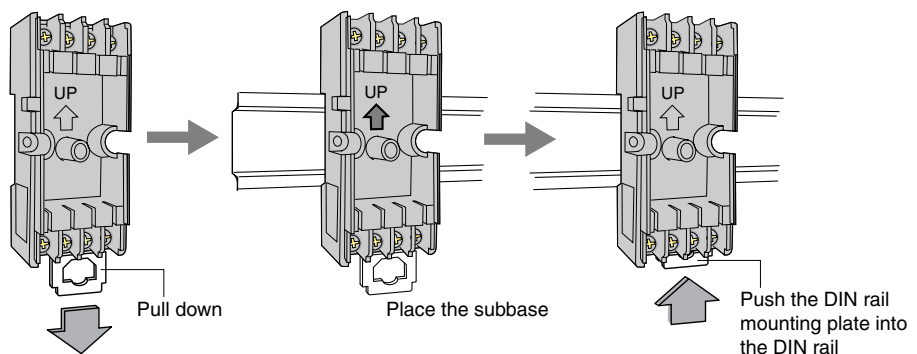


- Do not mount below direction.

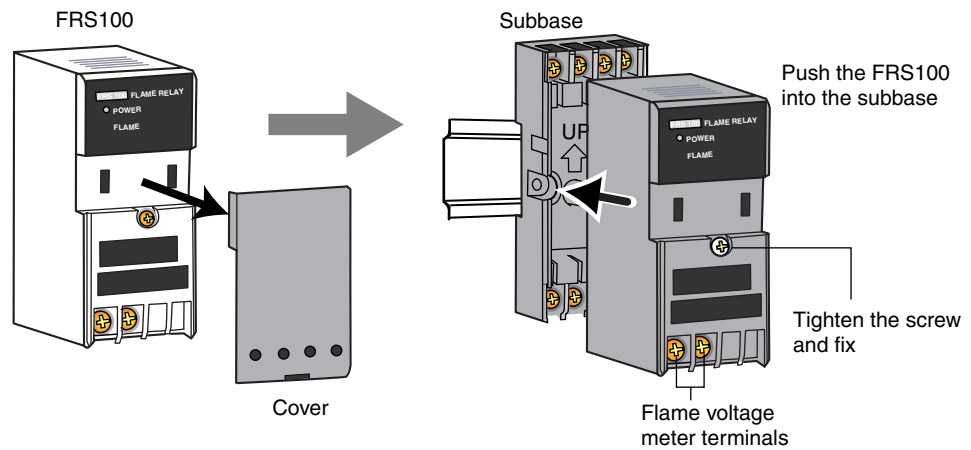


● **DIN rail mounting**

- (1) Pull the DIN rail mounting plate downwards.
- (2) Place the subbase on the DIN rail so that the arrow on the subbase is facing upwards.
- (3) Push in DIN rail mounting plate into the DIN rail.



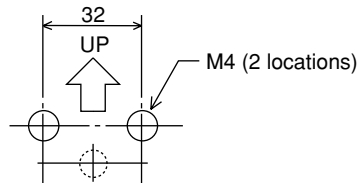
- (4) Wire the subbase terminals as instructed in 2-2 Wiring.
- (5) Pull the bottom of the controller cover downwards to remove.
- (6) Press the controller into the subbase with the display facing upwards.
- (7) Tighten the mounting screw on the center of the body to fix onto the subbase with a maximum torque of 0.3N•m.



- (8) If necessary, wire the flame voltage meter terminals.
- (9) Mount the cover on the control body.

● **Direct panel mounting**

- (1) Drill two M4 mounting holes in the panel so that the arrow on the subbase will be facing upward.



- (2) Attach the subbase to the panel using two M4 screws at a maximum torque of 0.7N•m.
- (3) Wire the subbase terminals as instructed in 2-2 Wiring.
- (4) Pull the bottom of the controller cover downwards to remove.
- (5) Press the controller into the subbase with the display facing upwards.
- (6) Tighten the mounting screw on the center of the body to fix onto the subbase with a maximum torque of 0.3N•m.
- (7) If necessary, wire the flame voltage meter terminals.
- (8) Mount the cover on the control body.

❗ **Handling Precautions**

- Do not tighten the subbase mounting screws using a torque exceeding the maximum torque. Doing so might damage the subbase.

2 - 2 Wiring

WARNING



Wire terminals 1 and 2 so that they receive power continuously whenever the power switch is turned on. This is absolutely necessary to ensure operation of the self-check circuits at startup.

Therefore, do not wire a thermostat between the power switch and terminal 1 or 2. Doing so might cause a serious combustion equipment accident.



Connect loads (ignition transformer, solenoid valve, etc.) directly to the output terminals of this device. If they are not directly connected, combustion safety cannot be ensured.

CAUTION



If timers and auxiliary relays are needed for additional functions, select ones with high reliability, and be sure to design the circuit correctly



Make sure the load connected to each terminal does not exceed the rating indicated in the specifications.



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.



Run the high-voltage ignition transformer cable separately and keep it at least 10 cm away from this device.



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.



Keep power lines and ignition transformer high-voltage cables separate from the flame detector wires.



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.



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 .

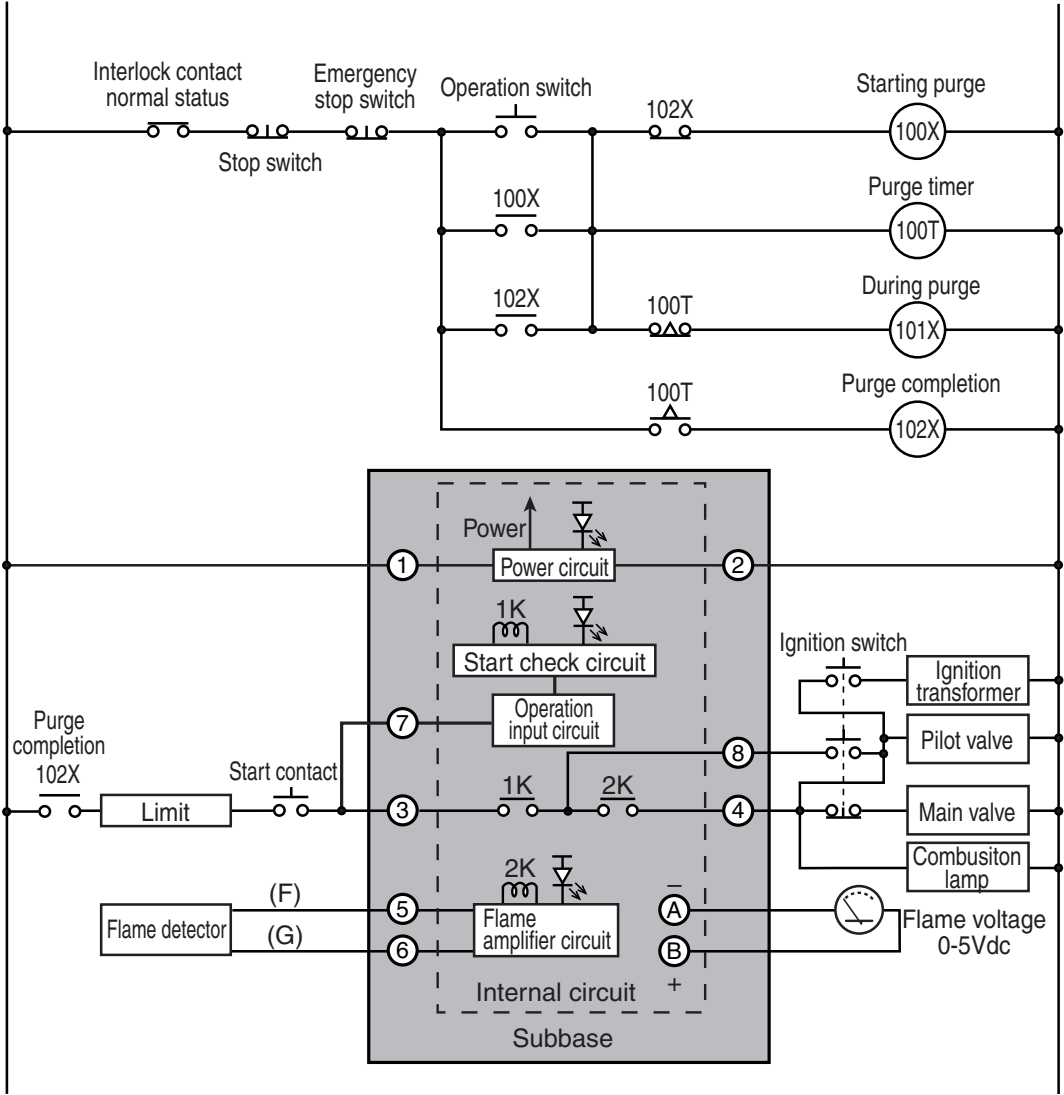


After the wiring is complete, be sure to check that it is correct. Incorrect wiring may cause damage or faulty operation.

■ Manual ignition (intermittent pilot)

High voltage side

Ground side



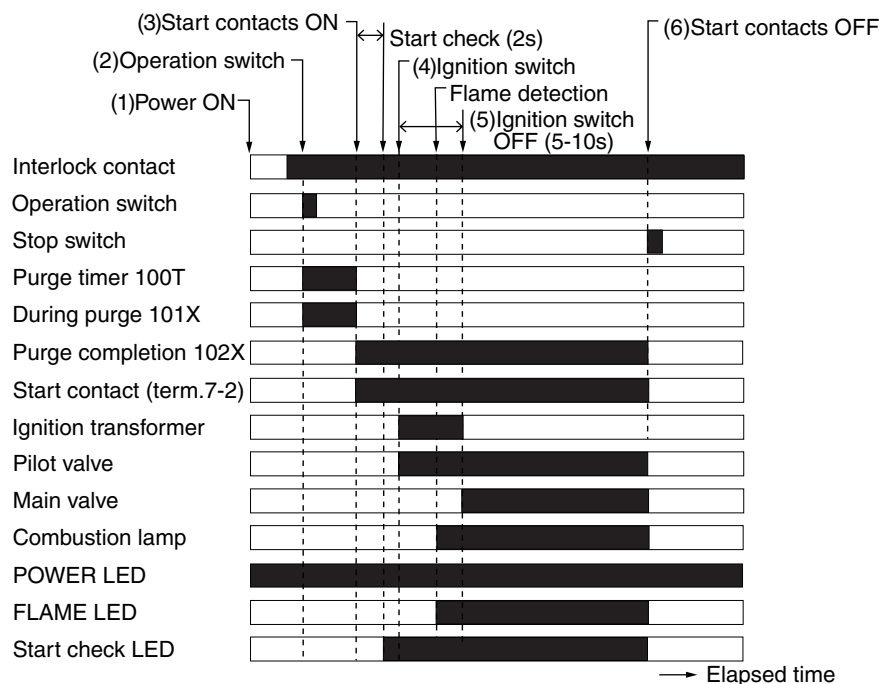
⚠ Handling Precautions

- When the high voltage side is distinguishable from the ground side, connect the high voltage side to terminal 1 and the ground side to terminal 2.

● Explanation of operation

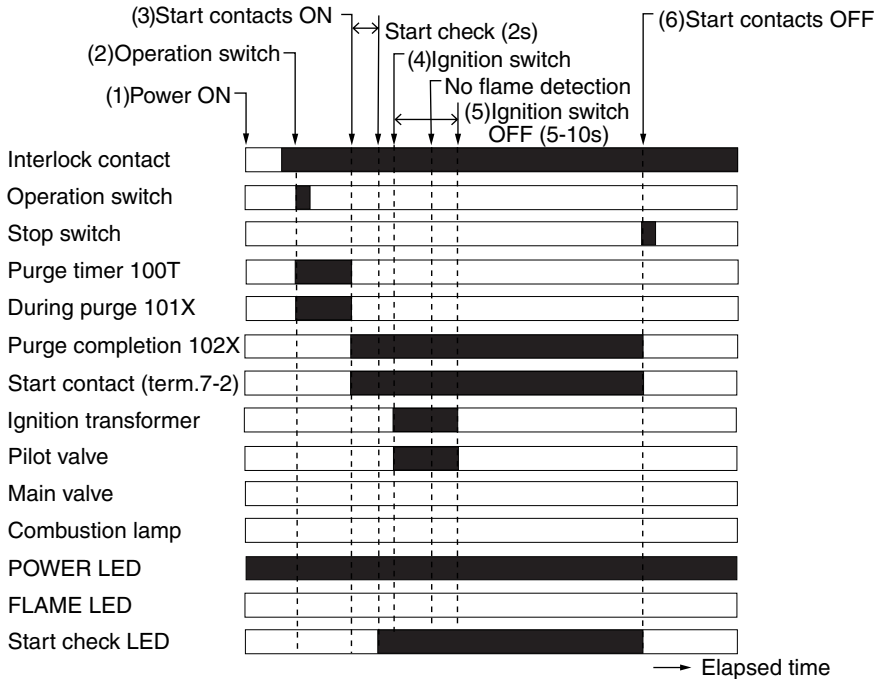
• Normal operation and shutdown

No	Input status	FRS100 activity	Output activity
1	Power ON	Receives power across terminals 1 and 2.	(POWER LED lights up)
2	Push-button operation switch ON	If the system is ready for operation, with interlock contacts in their normal state (closed), when the operation button is pushed, the prepurge begins. When the time preset for the purge timer (100T) has elapsed, the purge completion relay (102X) is energized. After the prepurge ends, the FRS100 accepts the following operations:	Purge completion (102X)
3	Start contacts ON	If the limit switch status is normal (contacts closed), pushing the start button applies power across terminals 7 and 2. Then, after completion of the start check, relay 1K turns on.	(Start check operation LED lights)
4	Ignition switch ON	When the ignition switch is pushed (contacts closed), terminal 8 supplies power to the pilot valve and ignition transformer. The ignition transformer turns on and the pilot valve opens.	<ul style="list-style-type: none"> • Ignition transformer ON • Pilot valve opens
		The flame detector detects the pilot burner flame. Relay 2K turns on. When relay 2K turns on, power is supplied through terminal 4 and the combustion lamp lights up.	<ul style="list-style-type: none"> • (FLAME LED lights) • Combustion lamp lights
5	Ignition switch OFF	The N.O. contacts of the ignition switch open, cutting power to the ignition transformer, which turns off. Since power is supplied through relays 1K and 2K, power through terminal 4 continues to maintain the operation of the pilot valve. When the ignition switch is turned off, its N.C. contacts close, supplying power to the main valve, which opens.	<ul style="list-style-type: none"> • Ignition transformer OFF • Pilot valve continues open • Main valve opens
6	Start contacts OFF	The power applied across terminals 7 and 2 is cut, relay 1K turns off, and the power to terminal 4 is also cut. The pilot valve and main valve close and the combustion lamp turns off.	<ul style="list-style-type: none"> • Pilot valve closes • Main valve closes (FLAME LED turns off)
		All loads are de-energized, and when the flame detector detects the flame failure, relay 2K turns off. The FRS100 returns to standby status and waits for the next start signal.	<ul style="list-style-type: none"> • Combustion lamp turns off • (Start check operation LED turns off)



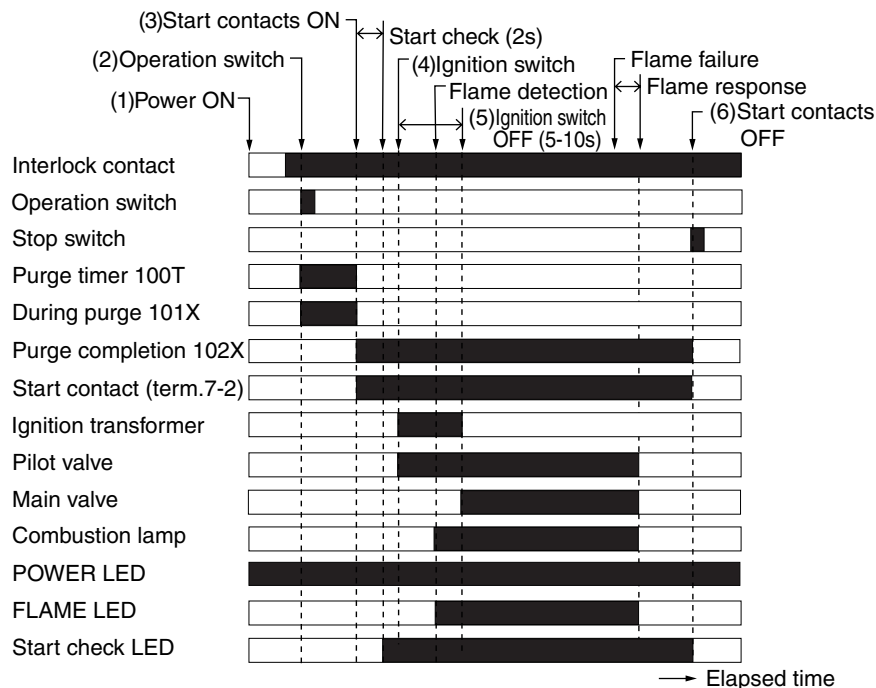
• Ignition failure

No	Input status	FRS100 activity	Output activity
1	Power ON	Receives power across terminals 1 and 2.	(POWER LED lights up)
2	Push-button operation switch ON	If the system is ready for operation, with interlock contacts in their normal state (closed), when the operation button is pushed, the prepurge begins. When the time preset for the purge timer (100T) has elapsed, the purge completion relay (102X) is energized. After the prepurge ends, the FRS100 accepts the following operations:	Purge completion (102X)
3	Start contacts ON	If the limit switch status is normal (contacts closed), pushing the start button applies power across terminals 7 and 2. Then, after completion of the start check, relay 1K turns on.	(Start check operation LED lights)
4	Ignition switch ON	When the ignition switch is pushed (contacts closed), terminal 8 supplies power to the pilot valve and ignition transformer. The ignition transformer turns on and the pilot valve opens.	<ul style="list-style-type: none"> • Ignition transformer ON • Pilot valve opens
		If the pilot burner fails to ignite, the flame detector cannot detect the pilot burner flame, and relay 2K does not turn on.	
5	Ignition switch OFF	Since the ignition switch contacts are open, power to the ignition transformer is cut, and ignition transformer operation stops. Because relay 2K did not turn on, the voltage at terminal 4 is zero, and the pilot valve returns closed. Voltage is also not supplied to the main valve, so it does not open.	<ul style="list-style-type: none"> • Ignition transformer OFF • Pilot valve closes
6	Start contacts OFF	Power across terminals 7 and 2 is cut, and relay 1K turns off.	(Start check operation LED turns off)
		The FRS100 returns to standby status and waits for the next start signal.	



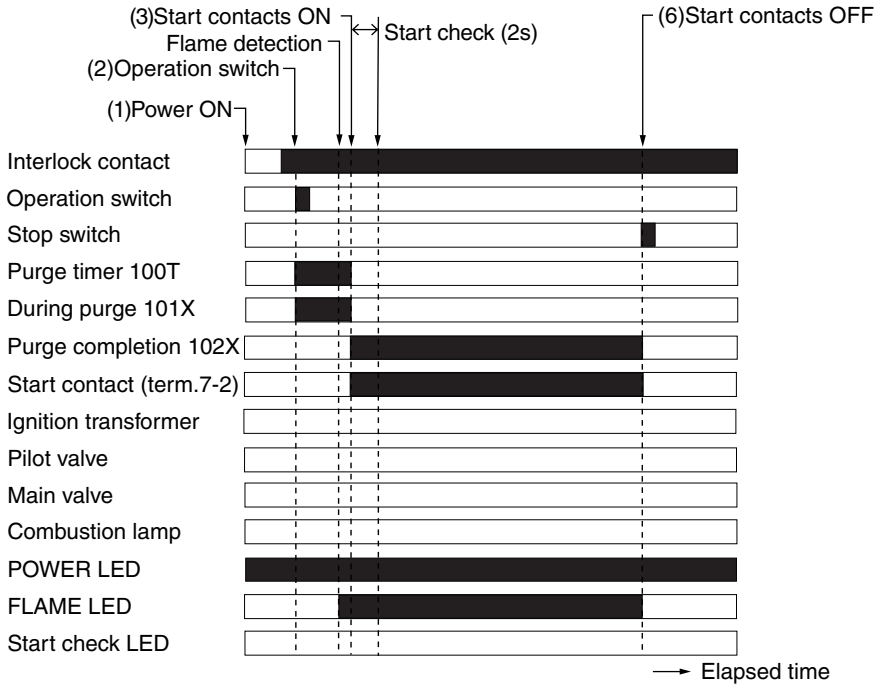
• Flame failure during combustion

No	Input status	FRS100 activity	Output activity
1	Power ON	Receives power across terminals 1 and 2.	(POWER LED lights up)
2	Push-button operation switch ON	If the system is ready for operation, with interlock contacts in their normal state (closed), when the operation button is pushed, the prepurge begins. When the time preset for the purge timer (100T) has elapsed, the purge completion relay (102X) is energized. After the prepurge ends, the FRS100 accepts the following operations:	Purge completion (102X)
3	Start contacts ON	If the limit switch status is normal (contacts closed), pushing the start button applies power across terminals 7 and 2. Then, after completion of the start check, relay 1K turns on.	(Start check operation LED lights)
4	Ignition switch ON	When the ignition switch is pushed (contacts closed), terminal 8 supplies power to the pilot valve and ignition transformer. The ignition transformer turns on and the pilot valve opens.	<ul style="list-style-type: none"> • Ignition transformer ON • Pilot valve opens
		The flame detector detects the pilot burner flame. Relay 2K turns on. When relay 2K turns on, power is supplied through terminal 4 and the combustion lamp lights up.	<ul style="list-style-type: none"> • (FLAME LED lights) • Combustion lamp lights
5	Ignition switch OFF	The N.O. contacts of the ignition switch open, cutting power to the ignition transformer, which turns off. Since power is supplied through relays 1K and 2K, power through terminal 4 continues to maintain the operation of the pilot valve. When the ignition switch is turned off, its N.C. contacts close, supplying power to the main valve, which opens.	<ul style="list-style-type: none"> • Ignition transformer OFF • Pilot valve continues open • Main valve opens
6	Flame failure occurs	Relay 2K turns off after the flame response period, the voltage that was supplied from terminal 4 is cut off, the pilot valve and the main valve close, and the combustion lamp turns off.	<ul style="list-style-type: none"> • (FLAME LED turns off) • Pilot valve closes • Main valve closes • Combustion lamp turns off
7	Start contacts OFF	Power across terminals 7 and 2 is cut, and relay 1K turns off.	(Start check operation LED turns off)
		The FRS100 returns to standby status and waits for the next start signal.	



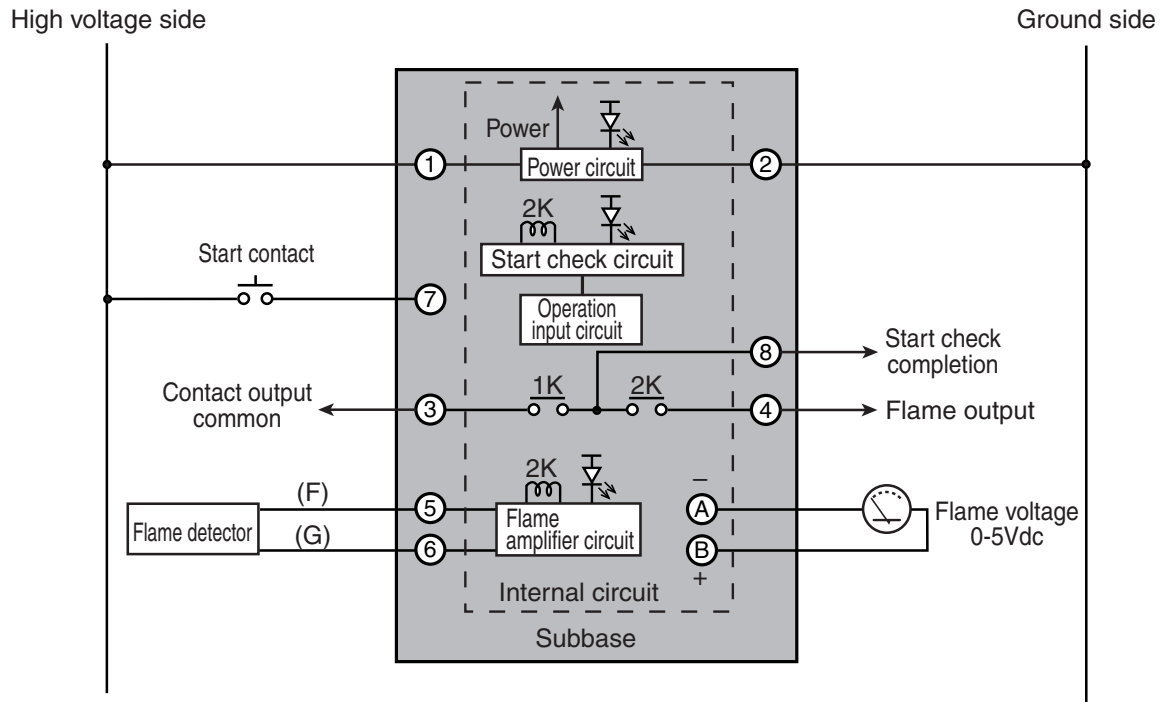
• False flame detection during startup

No	Input status	FRS100 activity	Output activity
1	Power ON	Receives power across terminals 1 and 2.	(POWER LED lights up)
2	Push-button operation switch ON	If the system is ready for operation, with interlock contacts in their normal state (closed), when the operation button is pushed, the prepurge begins. When the time preset for the purge timer (100T) has elapsed, the purge completion relay (102X) is energized. After the prepurge ends, the FRS100 accepts the following operations:	Purge completion (102X)
3	Start contacts ON	When the limit switch is in a normal state (contacts closed), pushing the start button applies power across terminals 7 and 2. The start check is carried out, but relay 1K does not turn on because a false flame is detected.	(FLAME LED lights up)
4	Ignition switch ON	Even though the ignition switch contacts are closed, no voltage is applied to terminal 8, and so the ignition transformer and the pilot valve do not operate.	
5	Ignition switch OFF	The ignition switch contacts open, and relays 1K and 2K remain off. No voltage is supplied from terminal 4, and the load is not energized.	
6	Start contacts OFF	The power across terminals 7 and 2 is cut off, and the FRS100 returns to standby status and waits for the next start signal.	(FLAME LED turns off)



■ **Burner flame monitoring only**

(In a case where the FRS100 is not used in its usual combustion safety role of shutting valves, etc.)



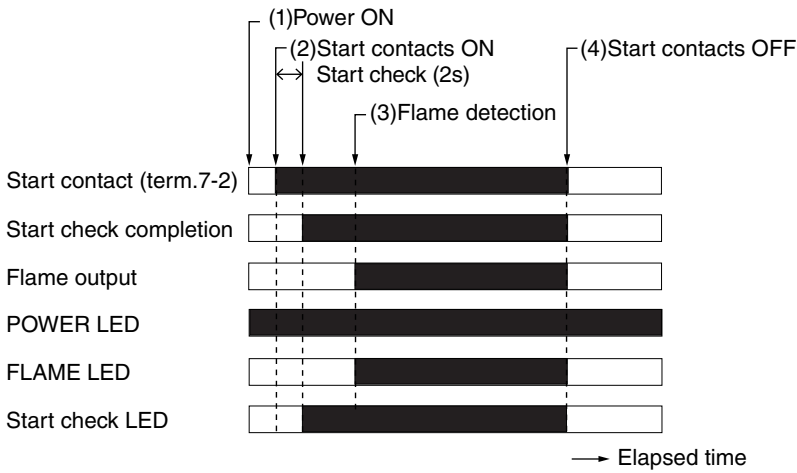
❗ **Handling Precautions**

- When the high voltage side is distinguishable from the ground side, connect the high voltage side to terminal 1 and the ground side to terminal 2.

● Explanation of operation

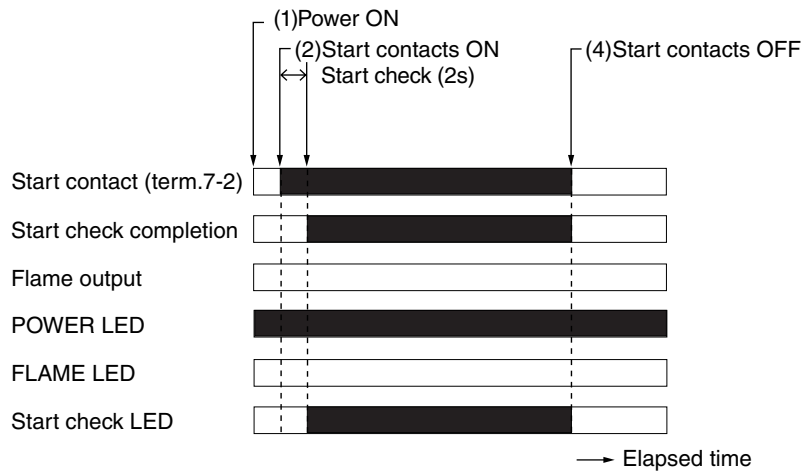
• Normal operation

No	Input status	FRS100 activity	Output activity
1	Power ON	Power is applied across terminals 1 and 2.	(POWER LED lights)
2	Start contacts ON	Pressing the start contact supplies power across terminals 7 and 2. After completion of the start check, relay 1K turns on. Since relay 1K turns on, the start check completion output from terminal 8 turns on.	<ul style="list-style-type: none"> • (Start check operation LED lights up) • Start check completion output turns on
3	Flame detection	The flame detector detects the flame of the pilot burner. Relay 2K turns on. Since relay 2K turns on, the flame output from terminal 4 turns on.	<ul style="list-style-type: none"> • (FLAME LED lights up) • Flame output ON
4	Start contacts OFF	<p>The power supplied across terminals 7 and 2 is cut off, relay 1K turns off, and the power to terminals 4 and 8 is also cut off. The start check completion output and flame output turn off.</p> <p>Since the flame detector detects a flame failure, relay 2K turns off. The FRS100 returns to standby status and waits for the next start signal.</p>	<ul style="list-style-type: none"> • (Start check LED turns off) • Start check completion output OFF • (FLAME LED turns off) • Flame output OFF



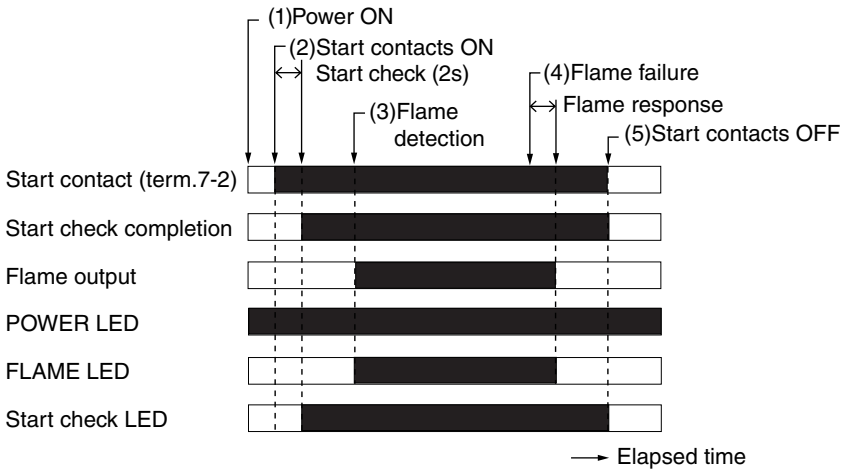
• Ignition failure

No	Input status	FRS100 activity	Output activity
1	Power ON	Power is applied across terminals 1 and 2.	(POWER LED lights)
2	Start contacts ON	Pressing the start contact supplies power across terminals 7 and 2. After completion of the start check, relay 1K turns on. Since relay 1K turns on, the start check completion output from terminal 8 turns on.	<ul style="list-style-type: none"> • (Start check operation LED lights up) • Start check completion output turns on
3	Ignition failure	If the burner does not ignite, the flame detector does not detect a burner flame, and relay 2K does not turn on.	
4	Start contacts OFF	<p>The power supplied across terminals 7 and 2 is cut off, relay 1K turns off, power to terminals 4 and 8 is cut off, and the start check completion output turns off.</p> <p>The FRS100 returns to standby status and waits for the next start signal.</p>	<ul style="list-style-type: none"> • (Start check LED turns off) • Start check completion output OFF



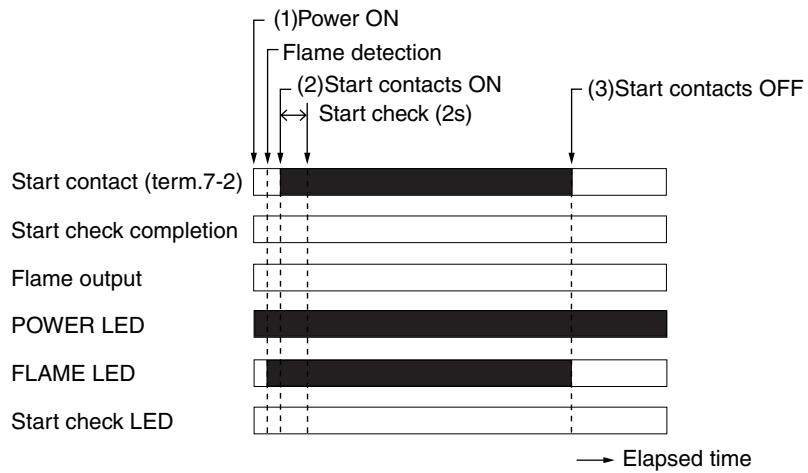
• Flame failure during combustion

No	Input status	FRS100 activity	Output activity
1	Power ON	Power is applied across terminals 1 and 2.	(POWER LED lights)
2	Start contacts ON	Pressing the start contact supplies power across terminals 7 and 2. After completion of the start check, relay 1K turns on. Since relay 1K turns on, the start check completion output from terminal 8 turns on.	<ul style="list-style-type: none"> • (Start check operation LED lights up) • Start check completion output turns on
3	Flame detection	The flame detector detects the flame of the pilot burner. Relay 2K turns on. Since relay 2K turns on, the flame output from terminal 4 turns on.	<ul style="list-style-type: none"> • (FLAME LED lights up) • Flame output ON
4	Flame failure occurs	After the flame response period, relay 2K turns off, the voltage supplied from terminal 4 is cut off, and the flame output turns off.	<ul style="list-style-type: none"> • (FLAME LED turns off) • Flame output OFF
5	Start contacts OFF	<p>The power supplied across terminals 7 and 2 is cut off, relay 1K turns off, power to terminals 4 and 8 is cut off, and the start check completion output turns off.</p> <p>The FRS100 returns to standby status and waits for the next start signal.</p>	<ul style="list-style-type: none"> • (Start check LED turns off) • Start check completion output OFF



• False flame is detected at startup

No	Input status	FRS100 activity	Output activity
1	Power ON	Power is applied across terminals 1 and 2.	(POWER LED lights)
2	Start contacts ON	By pushing the start contacts, power is applied across terminals 7 and 2. The start check is carried out, and relay 1K does not turn on because a false flame is detected.	(FLAME LED lights)
3	Start contacts OFF	Power across terminals 7 and 2 is cut off. The FRS100 returns to standby status and waits for the next start signal.	(FLAME LED turns off)

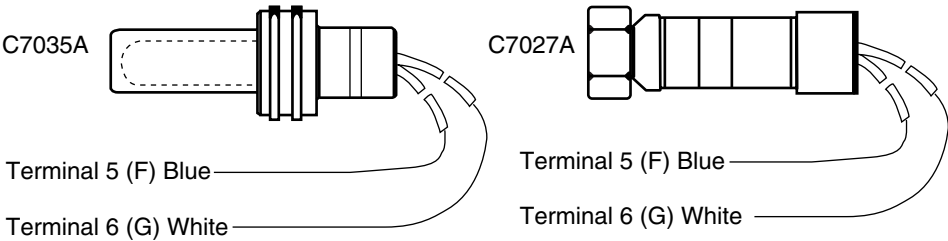


■ Wiring the flame detector

⚠ CAUTION

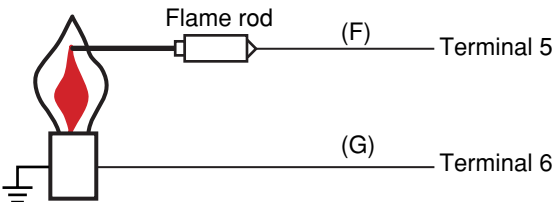
! Connect the blue signal lead from the Minipeeper Ultraviolet Flame Detector to terminal 5 and the white lead to terminal 6. Turning on the power when the flame detector is incorrectly wired could damage the UV tube.

● Wiring between the C7035/C7027 Minipeeper Ultraviolet Flame Detector and the FRS100C



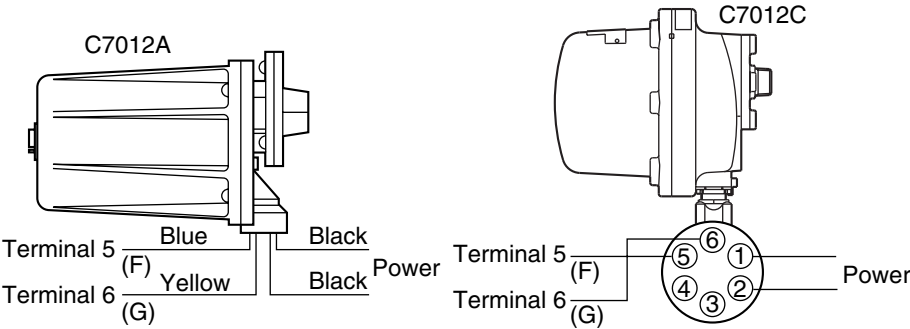
- Allowable lead length
- Type of signal lead 2mm², 600Vac IV (indoor vinyl) insulated power lead
- Allowable lead length Approx. 200m

● Wiring between the Flame Rod and the FRS100B



- Allowable lead length
- Type of signal lead High-frequency coaxial cable 5C2V, 7C2V
- Allowable lead length Approx. 30m

● Wiring between the C7012A, C7012C Ultraviolet Flame Detector and the FRS100B



- Allowable lead length
- Type of signal lead High-frequency coaxial cable 5C2V, 7C2V
- Allowable lead length Approx. 50m

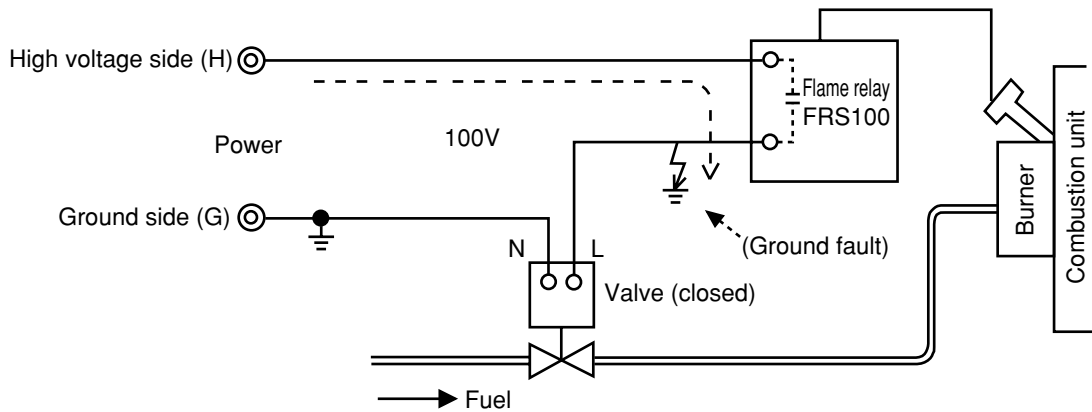
■ Wiring the solenoid valve

⚠ CAUTION



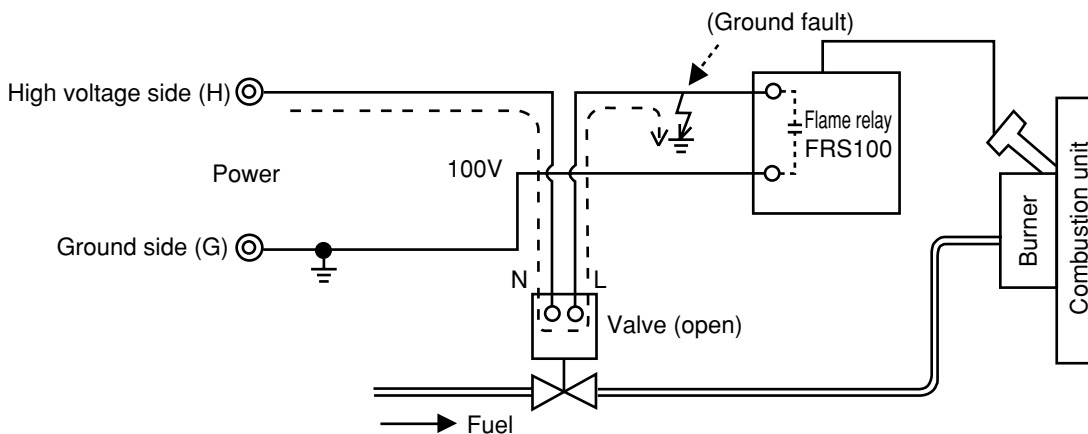
Do not connect a solenoid valve to the high voltage side of the circuit. If a ground fault occurs, the ground fault current may energize and open the solenoid valve. This device will not be able to prevent the valve from opening and fuel from flowing out.

● Correct connection



Ground current will not flow to the solenoid valve if the valve is wired as shown in the figure above, even if faulty insulation on the voltage side (H) causes a ground fault. Accordingly, the valve will not open, eliminating the risk of fuel discharge.

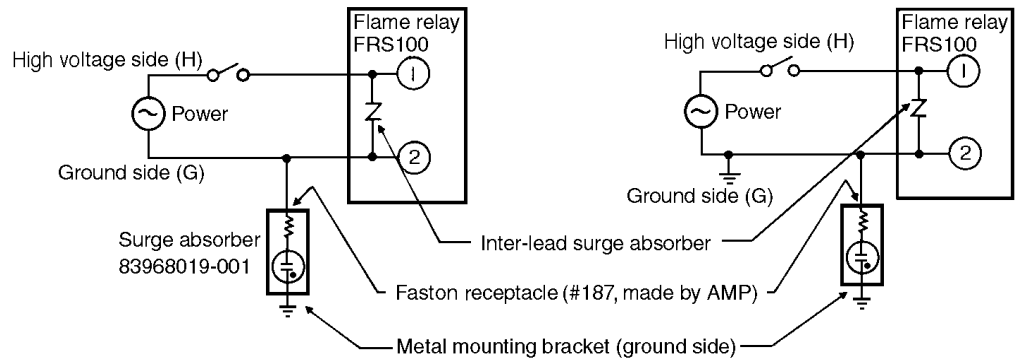
● Wrong connection



Ground current will flow to the solenoid valve if the valve is wired as shown in the figure above and if a ground fault occurs. Accordingly, the solenoid valve will open regardless of the flame relay, causing fuel discharge.

■ Wiring the surge absorber

Wire as shown below when using a surge absorber (model No.83968019-001, ordered separately) for protection from lightning surge.







! Handling Precautions



- Use a JIS C 3306, 0.75mm² power lead (lead diameter 0.18, 30-strand) or higher for wiring to the power supply.
- Attach a Faston receptacle (#187, made by AMP) to one end of the power lead, and make the wire connection as short as possible.
- Ground the surge absorber mounting bracket by attaching to a grounded metal part such as the burner body.

Chapter 3. ADJUSTMENTS FOR TRIAL OPERATION

WARNING

-  Do not allow the pilot or main burner "Safety Time" (ignition trial time) to exceed the specifications of the burner or equipment manufacturer. If they do, fuel may accumulate in the combustion chamber and form an explosive air-fuel mixture, resulting in a serious explosion hazard.
-  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.
-  Before the pilot turndown test or ignition spark response test, make sure that all manual fuel valves are closed.
-  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.

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.
-  Check the flame current at least once per month. Doing so can prevent shutdowns caused by a weak flame current signal.

■ Outline

The following table shows the test adjustment items described in this chapter:

Item	Applicable Unit
Flame signal measurement method	All units
Pilot turndown test	Units using the pilot burner
Ignition spark response test	All units
Safety shutdown test	All units

Handling Precautions

- After adjusting the above items, make sure that all of the adjustment requirements are satisfied. All of the adjustment requirements must be satisfied by the final mounting position of the flame detector.

● Required equipment

- Tester (input impedance, 100kΩ or more)
Range: 0 to 300Vac, 0 to 5Vdc
- Two jumper leads with crocodile clips, AWG14 (2mm²) or more, approximately 30cm long.
- Insulation tester: 500Vdc megger

● Preliminary inspection

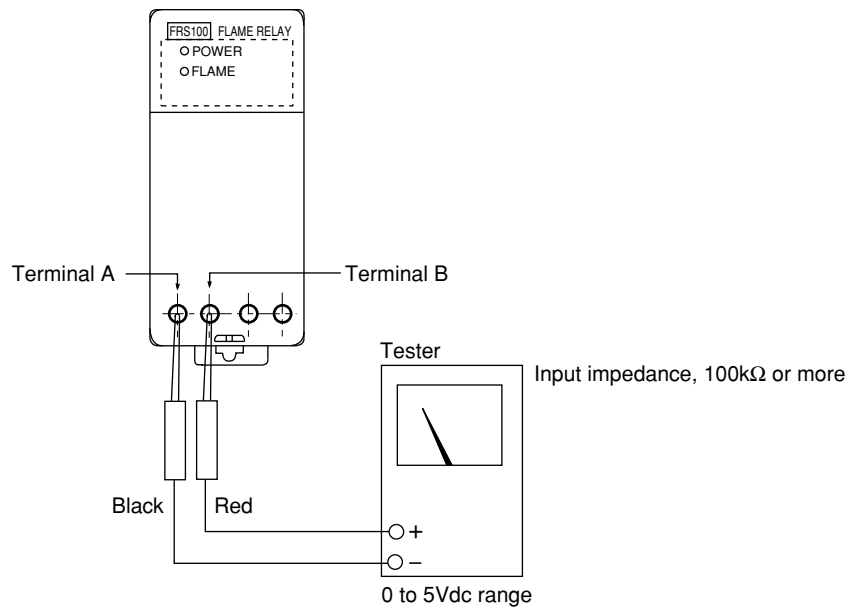
- Check all connections.
- Make sure that the controller is mounted at a location within the allowable ambient temperature.

- Make sure that the flame detector is properly mounted.
(Refer to its instruction manual.)
- Disconnect the loads and flame detector wiring. Measure the insulation resistance across the terminals and panel ground, and make sure that the resistance is 50MΩ or more using an insulation tester or megger of 500Vdc or more.
- Check that all fuel valves and cocks are closed, and the combustion chamber has been completely vented.

■ How to measure the flame signal

! Handling Precautions

- When using the high-sensitivity model, limit the flame voltage to 4.5V or less.
- (1) Start the controller, and measure the flame voltage for each burner under various conditions (at startup, normal operation, etc.).
 - (2) When measuring the flame voltage, insert the tester probes into the holes to connect to terminals A and B at the bottom front of the controller as shown below.



- (3) Refer to the following table for voltage values:

Recommended flame voltage	Checklist
2Vdc min.	<ul style="list-style-type: none"> • Make sure that flame monitoring is correct. • The viewing window of the flame detector must be free of dirt. • The monitoring tube must not be blocked with soot.

- (4) If the flame signal fluctuates, check the flame detector mounting position and wiring again.

■ Pilot turndown test

This test is intended to check that the flame is reliably transferred to the main burner when the flame detector detects the pilot flame, even if gas pressure and air pressure change to their worst conditions.

WARNING



Do not allow the pilot or main burner "Safety Time" (ignition trial time) to exceed the specifications of the burner or equipment manufacturer. If they do, fuel may accumulate in the combustion chamber and form an explosive air-fuel mixture, resulting in a serious explosion hazard.



Carry out the pilot turndown test carefully. If the flame detector is set so that it detects a pilot flame that is too small to ignite the main burner, this device will not be able to detect a flame failure in the main burner. In that case, fuel will continue to be supplied, causing a serious explosion hazard.



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.

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.

Handling Precautions

- If a fuel pressure limit switch is used, and its contacts are open, turn it ON with a jamper cable during this test.

● Test procedure

- (1) Turn the operation switch OFF.
- (2) Close the manual valves to stop the gas supply to the pilot burner and main burner.
- (3) Open the manual valve to the pilot burner.
- (4) Turn the power switch ON, and then turn the start switch on, and press and hold the ignition switch. The pilot will ignite and the pilot valve will open. Ignition will begin and the combustion lamp will light. Release the ignition switch.

- (5) Close the pilot manual valve slowly. The pilot flame will gradually grow smaller. Continue to close the manual valve until the flame detector can not detect the flame.
Record the gas pressure immediately before the flame relay turns OFF and the combustion lamp is lit up.
- (6) Open the manual valve for the pilot slowly to adjust the pressure to a level immediately before the combustion lamp goes off. Then, press the ignition switch again to ignite the pilot.
- (7) Release the ignition switch.
Open the manual valve for the main burner and check that the main burner ignites smoothly within one second after the valve is opened.
- (8) Try different gas pressures between the minimum and maximum levels, igniting the main burner five or six times. Make sure that the main burner ignites smoothly every time.
- (9) If the main burner does not ignite properly, the reason is probably that the pilot flame is too small. Increase the size of the pilot flame, and carry out the following adjustment:
 - Either slightly take the monitor line of the flame detector away from the axis of the pilot flame, or stop the iris down to correct the visible flame size. (Set the flame size so that the main pilot ignites smoothly at the minimum flame sensitivity.)
- (10) After making this adjustment, repeat steps 5 to 8, and make sure that main burner ignition is reliable.
- (11) When this test is completed, return the manual valve for the main burner to its fully open position. Check that the flame signal is appropriate.
- (12) If any limit switch has jumper cables attached, disconnect them to return the limit switch to its previous state.

■ Ignition spark response test

This test should be carried out on any equipment that uses an ultraviolet flame detector. The test is to check that the ultraviolet flame detector does not respond to UV rays emitted from the ignition spark.

● Ultraviolet flame detector

CAUTION



Make sure that the flame detector does not detect the ignition spark. If the flame detector can detect the spark, change the detector's line of sight or change the ignition electrode's position.



Make sure the flame detector does not detect ultraviolet rays other than those of the burner flame. If the flame detector responds to other ultraviolet rays, it will report that there is a flame even if the burner flame goes out. As a result, fuel will continue to be discharged, causing a very serious explosion hazard.

Carry out the following test to check that the ultraviolet flame detector or flame rod does not respond to the UV rays emitted from the ignition spark (so that the FLAME LED does not light up).

- (1) Close the manual fuel valves to the pilot and main burners.
- (2) Start the combustion equipment and measure the flame voltage in the pilot ignition sequence to check whether or not there is an effect on the flame voltage.
- (3) If the FLAME LED is lit, make adjustments using the following procedure while referring to the equipment user's manual.
 - Move of the ultraviolet sensor or flame rod so that there is no effect.
 - Put a shielding plate in the optical path of the ultraviolet sensor so that the effect of the spark on the flame voltage is 0.4Vdc or less.

● Cautions regarding UV sources other than flames

The table below shows various radiation sources other than the burner flame that may activate the flame detector. Make sure that the flame voltage is not affected under any conditions of the flame response test.

Ultraviolet ray sources	Red-hot chamber wall with temperature 1260°C or more
	Sparks • Ignition transformer • Welding arc • Lightning
	Gas laser
	Sunlamp
	Germicidal lamp
	Strong flashlight (toward UV sensor)
Gamma ray and X-ray sources	Regression analyzer
	Electron microscope
	X-ray camera
	High-voltage vacuum switch
	High-voltage capacitor
	Radioactive isotope
	Other sources producing ultraviolet rays, gamma rays and X-rays

■ Safety shutoff test




After all operational adjustments have been completed, carry out the safety shutoff test.

- Pilot ignition failure (ignition failure)
 - (1) Close the manual fuel valves to the pilot and main burners.
 - (2) Press the ignition switch to begin combustion.
 - (3) The pilot valve opens for pilot burner ignition, but ignition is not possible. Check that the FLAME LED does not light up, and the main valve does not open.
Do not hold the ignition switch for a long time.








- Flame failure during normal combustion
 - (1) Open the pilot and main manual fuel valves.
 - (2) Press the ignition switch to start operation.
 - (3) When the sequence has progressed correctly and normal combustion (main valve open) has begun, close the pilot and main manual fuel valves to put out the burner flame. Then, check that the flame failure is detected and that safety shutoff occurs correctly.

Chapter 4. MAINTENANCE AND INSPECTION

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.
-  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.
-  To prevent electric shock, turn the power off and discharge terminals F and G before removing this device from the subbase. Use lead wires to connect terminals F and G of the flame simulator (FSP300C100) to terminals F and G of this device for 10 seconds or more.

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.
-  Conduct periodic inspections in accordance with the user's manual of the equipment manufacturer.
-  If the safety shutoff has been activated, check all of the items on the checklists in Chapter 3, ADJUSTMENTS FOR TRIAL OPERATION before restarting the equipment.
-  When doing a maintenance inspection of the burner, be sure to do the pilot turndown test. Inspection must be done at least once a year.
-  When cleaning the burner, clean the flame detector as well.
-  This device has an operating life. Assuming that the operating life of the combustion equipment used with this device is longer, be sure to do periodic maintenance and replacement of this device.
-  In the event that this device is replaced, do all of the checks listed in Chapter 3, ADJUSTMENTS FOR TRIAL OPERATION.

■ Frequency of maintenance and inspection

Determine an inspection cycle taking into consideration the following factors:

- Type of equipment
 - Ambient conditions of installation site (dust, temperature, etc.)
 - The effect of burner failure on equipment operation.
- (1) Carry out the safety shutoff test described in Chapter 3, ADJUSTMENTS FOR TRIAL OPERATION at least once a month.
 - (2) Measure the flame voltage at least once a month.
 - (3) Check the viewing window on the ultraviolet flame detector, the flame rod, etc. for dirt, and clean as necessary.
 - (4) Check the ambient temperature.
 - (5) If equipment will be seriously damaged by a burner failure, carry out this inspection more frequently.

■ Troubleshooting

If a problem occurs, remove the front cover of the controller. Determine the operating state of the controller and type of trouble by checking the start check, POWER and FLAME LED display states. The start check LED is located in the center inside the cover, and the POWER and FLAME LEDs are located on the front display.

○ LED out

● LED lit

	POWER LED	Start check LED	FLAME LED	Results	Remedy (check items)
Before startup, terminal 7 OFF	○	○	○	The power is not ON.	Check panel power switch and wiring.
After startup, terminal 7 ON	●	●	●	The flame is being detected. (normal operation)	-
	●	●	○	The flame has not been detected.	Check flame detector, burner, flame relay, valves, ignition transformer and flame relay.*
	●	○	●	False flame	Check burner flame, flame detector and flame relay.*
	●	○	○	1K relay is not ON.	Check power supply at operation input terminal (7). Check flame relay.*

* To check if the controller is operating correctly, apply a flame signal input to the controller by using a flame simulator. Make sure that 2K relay is turned ON and the FLAME LED is lit.

The following table shows the required flame voltages:

FRS100C	Standard model:	2V min.
	High sensitivity model:	3V min.
FRS100B	Standard model:	2V min.

● How to connect the flame simulator

- 123514A/B flame simulator
Contact the terminal 5 lead wire to the probe end.
Contact the terminal 6 lead wire to the plug end.
- 121708 flame simulator
Contact the terminal 5 to the F lug.
Contact the terminal 6 to the G lug.

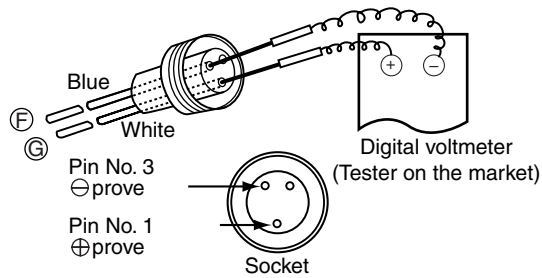
⚠ Handling Precautions

- Keep the check time short and remove the simulator promptly after completion of the check.
- Do not touch the terminals F and G during operation or during the check. Doing so might cause electric shock.

● **Wiring check of ultraviolet flame detector used with the FRS100C**

Check that the wiring to the ultraviolet flame detector is correct using the steps below.

- Procedure for the C7035
 - (1) Remove the ultraviolet tube from the socket.
 - (2) Supply power to the FRS100.
 - (3) Measure the DC voltage in the socket with a digital voltmeter or tester.
 - Connect the plus probe to the No. 1 pin on the socket (white wire)
 - Connect the minus probe to the No. 3 pin on the socket (blue wire)



- Reference voltage (by TR6841 of ADVANTEST)

Power voltage	Observed voltage
85%	+150 to 180Vdc
100%	+160 to 210Vdc
110%	+180 to 230Vdc

! **Handling Precautions**

- If the above measured value is negative, the wiring is probably reversed.
- Before mounting the UV tube, make sure that the wiring is correct.

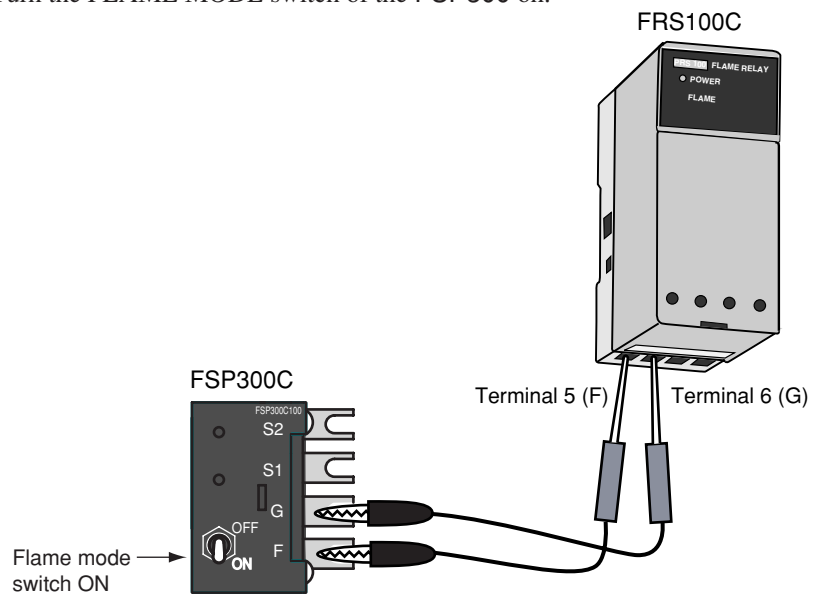
● Connecting a flame simulator (models FSP300, 121708 and 123514)

⚠ Handling Precautions

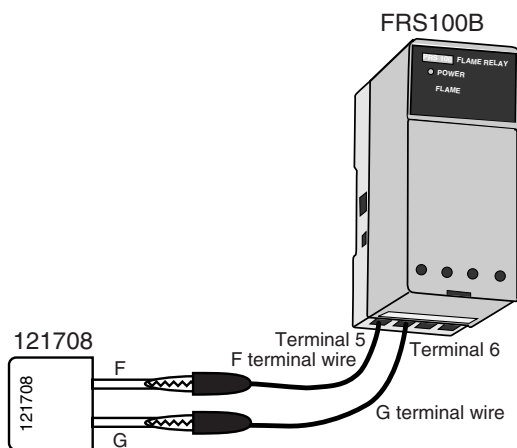
- Do the operation check in one sitting, and afterwards remove all test wiring at once.
- Do not touch terminals F and G during the operation check. Doing so might cause electric shock.

• FSP300

- (1) Wire terminals F to F and G to G as shown below.
- (2) Turn the FLAME MODE switch of the FSP300 on.

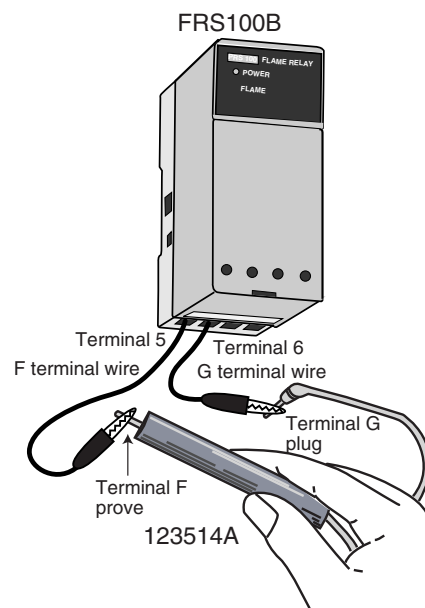


• 121708



Connect terminal 5 to terminal F and terminal 6 to terminal G.

• 123514A



Connect terminal 5 to the terminal F probe and terminal 6 to the terminal G plug.

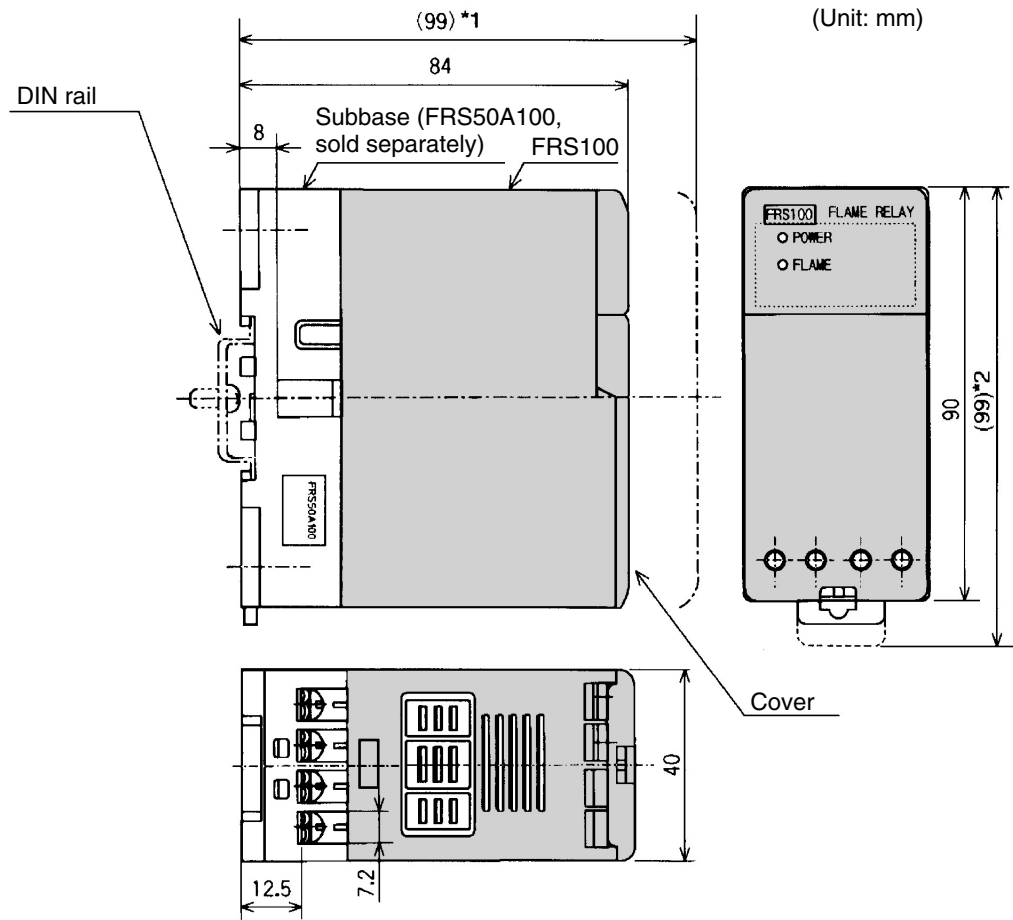
Chapter 5. SPECIFICATIONS

■ Specifications

Item	Specifications
Rated power supply	100Vac 50 / 60 Hz 200Vac 50 / 60 Hz
Allowable voltage	-15 to +10% of rated voltage
Power consumption	FRS100B: 3W max. FRS100C: 7W max.
Contact ratings	250VA: terminal 3-4 for flame output 250VA (1K and 2K) : terminal 3-8 for start check output 250VA (1K)
Flame sensitivity	Ignition detection level: Flame voltage: 1V or less Flame-out detection level: FRS100B series flame voltage: 0.2V or more FRS100C series flame voltage: 0.4V or more
Flame signal output	Use at least 0.75mm ² wire, a max. of 5m long, with IV (indoor vinyl) insulation. Output terminals: A (-) and B (+) on body Required input impedance of externally connected equipment: 100kΩ min.
Ambient temperature	Stand-alone mounting: -20 to +60°C Gang mounting (2 units or more): -20 to +45°C
Ambient humidity	90% RH 40°C (condensation not allowed)
Vibration resistance	4.9m/s ² max., 10 to 60Hz for 2h each in X, Y and Z directions (when directly mounted on panel)
Insulation resistance	50MΩ min. between terminals and ground terminal by 500Vdc megger
Dielectric strength	No failure after applying 1500Vac for 1min or 1800Vac for 1s between terminals and ground terminal (excluding flame detector input of terminals 5 and 6)
Lightning-induced surge	10kV, 1.2 x 50μs (JEC-187, surge impedance 75Ω or more) when the following surge absorber is attached to a power supply contact (terminal 2) and the ground terminal: • Recommended surge absorber: 83968019-001
Life	100,000 operations (at ordinary temperature and humidity, and rated voltage)
Body color	Gray
Mounting	Mounted on DIN rail or screw mounted (when using the FRS50A100 subbase)
Mass	FRS100B: Approx. 270g FRS100C: Approx. 270g FRS50A subbase : Approx. 70g
Optional parts (sold separately)	Subbase Model No.: FRS50A100 Flame Meter Model No.: FRS60A Lightning-induced surge absorber Model No.: 83968019-001 Flame Simulator for Flame Rod Model No.: 123514A, 121708 Flame Simulator for C7035A, C7027A Model No.: FSP300C

■ External dimensions

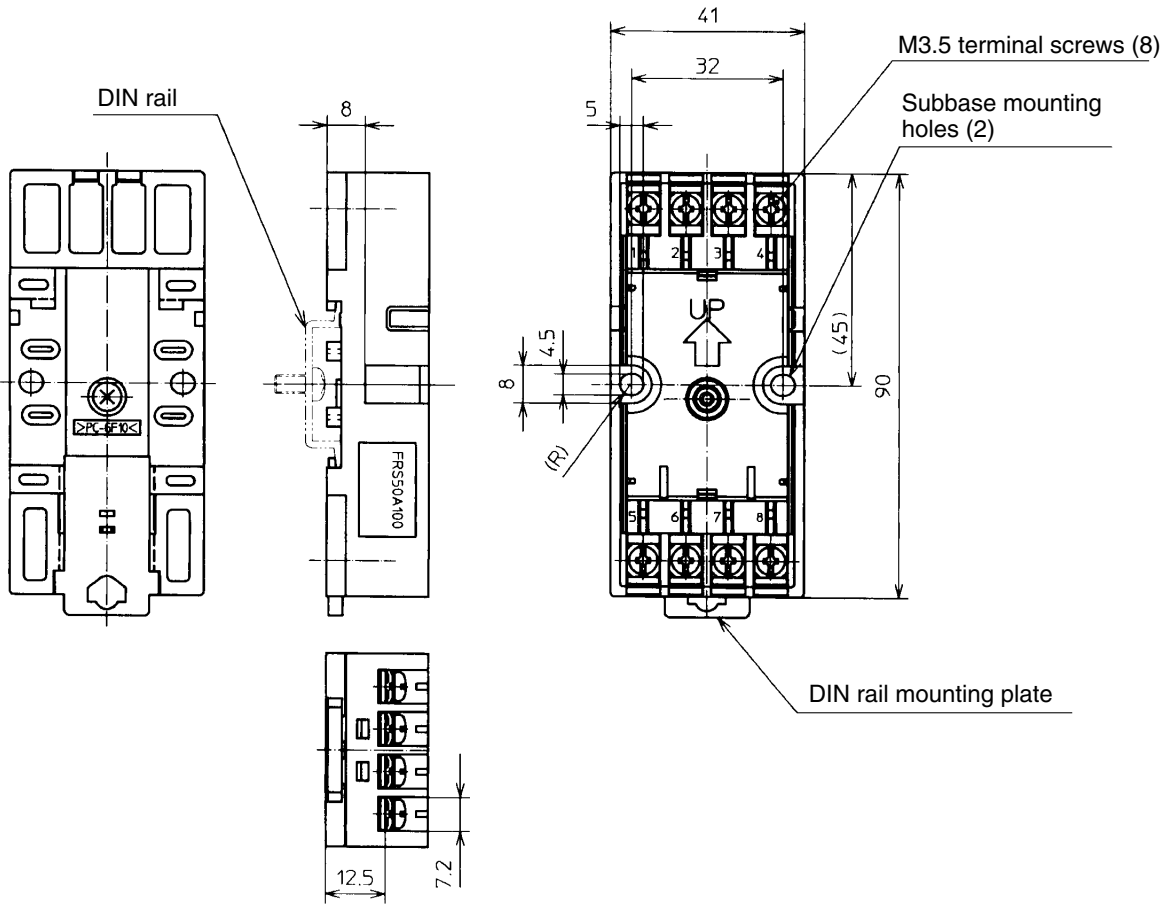
- FRS100 mounted on FRS50A100



*1. Space required to mount and remove the body

*2. Space required to mount and remove the body from DIN rail

● FRS50A100 subbase



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