



## UV-4 Flame Detector Manual

Publication 372000-28 Rev K

- BURNERS
- IGNITERS
- DAMPERS
- CONTROLS



[www.forneycorp.com](http://www.forneycorp.com)

# INTRODUCTION





This manual contains information for the UV-4 Flame Detector from Forney Corporation, 16479 Dallas Parkway, Suite 213, Addison, Texas. [www.forneycorp.com](http://www.forneycorp.com)

All personnel should become thoroughly familiar with the contents of this manual before attempting to use the UV-4 Flame Detector. Because it is virtually impossible to cover every situation that might occur during operation and maintenance of the equipment described in this publication, personnel are expected to use good engineering judgment when confronted with situations that are not specifically mentioned herein.

## PROPRIETARY NOTICE

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## SAFETY ICON DEFINITIONS

	<b>DANGER</b>	Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
	<b>WARNING</b>	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
	<b>CAUTION</b>	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
	<b>NOTICE</b>	Indicates unsafe practices that can result in property damage only.



## REVISIONS

REVISIONS	DATE	COMMENTS
A		Initial Release
B		
C		
D	10/2003	
E	11/2003	
F	12/2006	
G	11/2009	
H	6/2011	
J	5/2019	Update Safety Icons, Logos and addresses
K	12/2020	

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# SECTION 1

## General Description

The Forney UV-4 flame detector contains an ultraviolet (UV) sensor tube and signal-processing electronics inside a protective case. These components receive operating power and control inputs from an external amplifier assembly. During normal operation, light passes through a sight tube or a fiber-optic light guide and strikes the UV sensor tube. The signal-processing electronics inside the head convert pulses from the tube into a digital output signal whose frequency is directly proportional to the intensity of UV light striking the sensor tube. The output signal then is routed to the external amplifier assembly, which converts the signal from the head into digital flame on/off, analog intensity, and alarm output signals.



The UV-4 flame detector includes two major subassemblies: a head assembly and a base assembly. The head assembly (figure 1) consists of a machined housing that contains the internal electronics of the flame detector:

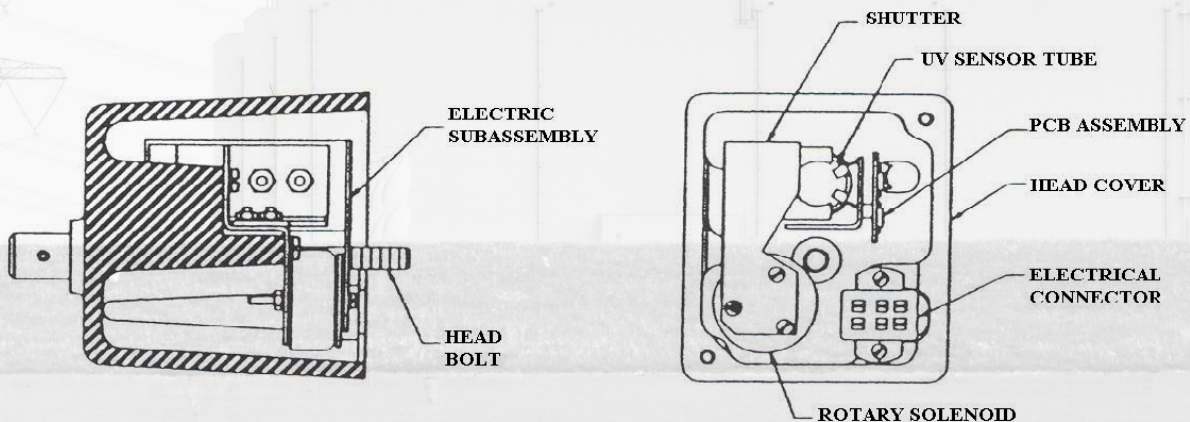


Figure 1 UV-4 Head Configuration

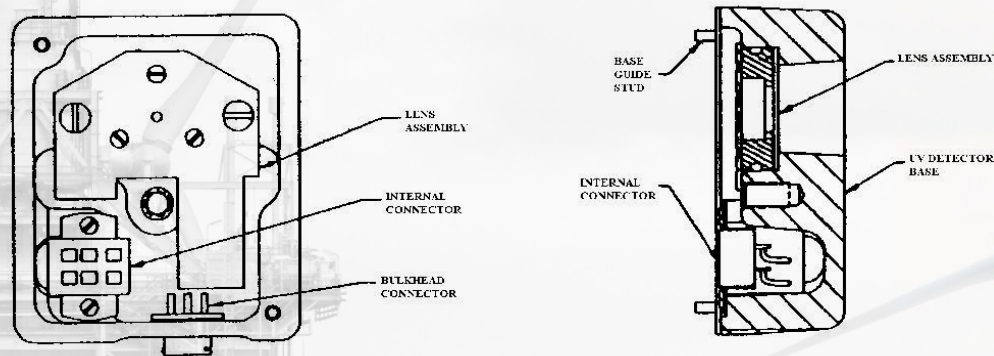


The sensor tube contains an ultraviolet-sensitive gas at reduced pressure. When UV light enters the tube, the gas ionizes, enabling current to flow between two electrodes. Signal conversion electronics on an internal printed circuit board (PCB) transforms the resulting voltage surges into digital pulses.

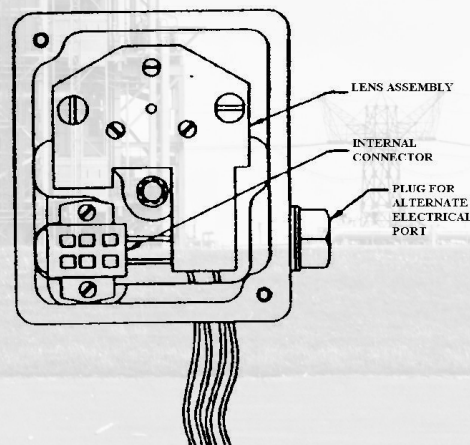
- The PCB contains a voltage level converter, optical isolator, and a single shot. These components supply the bias voltage required by the sensor tube and transform voltage transients into a well-defined digital pulse train.
- A rotary solenoid is located next to the UV sensor tube. When the external amplifier assembly energizes the solenoid, it moves a mechanical shutter into a position in front of the sensor. This action can be used to blind the flame detector for a self-test cycle or to disable the system when its operation is not required.
- A six-position electrical connector mates with a corresponding connector in the base assembly to facilitate installation or field replacement.

Forney offers UV-4 base assemblies having several different configurations. Figures 2 through 4 illustrate the major physical variations. The primary functional differences are as follows:

- A base with a lens assembly. This configuration is used for front-mount configurations. The lens assembly can be plain or magnifying glass and isolates the electronic components from furnace gases in the sight tube. The flame detector is available with either pigtail wiring or a bulkhead connector that provides the electrical interface with the external amplifier assembly.



**Figure 2 Base Assembly with Bulkhead Connector**



**Figure 3 Base Assemblies with Pigtail Wiring**

- A base with a fiber-optic light guide. This assembly includes a fiber-optic cable assembly instead of a lens. The fiber-optic light guide frequently is used to transmit light through the wind box of a tangentially fired furnace with tilting burners or in applications that lack the space for direct viewing. As before, the flame detector is available with either pigtail wiring or a bulkhead connector.

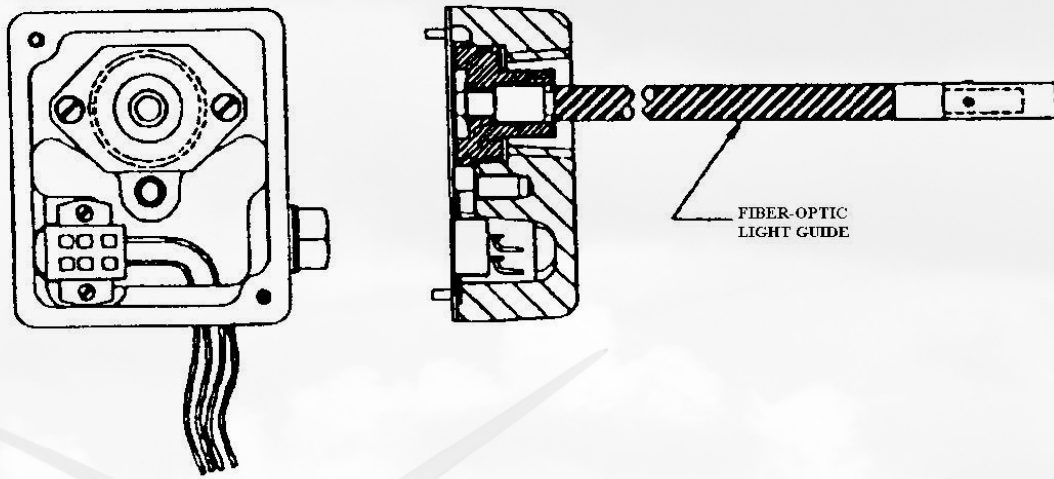


Figure 4 Base Assemblies with Fiber-Optics Light Guide

# 1.1 Mechanical Specifications

<b>Size</b>	Length 6 in Width 4 by 3.5 in.
<b>Weight</b>	4.4 lb
<b>Mounting-tube connection</b>	1-in NPT female
<b>Cooling-air connection</b>	1-in NPT female (part of mounting tube)
<b>Viewing angle</b>	The head has a 32° viewing angle that is restricted to an angle between 3° and 5° when attached to the mounting tube assembly; fiber-optic assemblies have a 22° viewing angle from a 3-in setback in the mounting tube.
<b>Temperature Requirements</b>	-25° C to 60° C (-13° F to 140° F) operating; -55° C to 125° C (-67° F to 257° F) storage
<b>Cooling-/Seal-Air Requirement</b>	Normally 10 SCFM at 5 inc. w.c., 120° F maximum temperature. Refer to submittal drawings for figures specific to this project.
<b>Spectral Response</b>	UV mode – 190 to 260 nanometers



# 1.2 Electrical Specifications

<b>Shutter Solenoid Power</b>	+14 ± 1 vdc @ 0.9 to 1.0 A nominal current
<b>Input Power</b>	+_ 15 vdc @ 47 mA nominal current
<b>Output Signal</b>	Open collector 500-µs digital pulse train
<b>Power Consumption</b>	12 vA maximum
<b>I/O Cable Connector</b>	MS3116E10-6S (units with bulkhead connector only)
<b>Bulkhead Connector</b>	MS3112E10-6P (units with bulkhead connector only)

A prefabricated four-wire, 2 – 18 AWG and 2 – 20 AWG, shielded cable assembly is available from Forney. Cable signal/connector pin assignments are as follows:

- Pin A shutter voltage (green wire – 18 AWG)
- Pin B common ground (black wire – 18 AWG)
- Pin C +15 vdc power (red wire – 20 AWG)
- Pin D output signal (white wire – 20 AWG)
- Cable Shield (connected to amplifier ground plain)

# SECTION 2

## Safety

Electrical power always should be removed from the flame detector amplifier before installing or replacing a flame detector head assembly. In addition, if a flame detector head must be replaced while the furnace is in operation, maintenance personnel should exercise care to avoid exposure to flying particles and hot furnace gas.



### WARNING

Before installing/removing a front-mount detector base, maintenance personnel should close the ball valve attached to the sight tube. In addition, maintenance personnel should wear safety glasses to prevent eye injury from pressurized gas and flying particles.



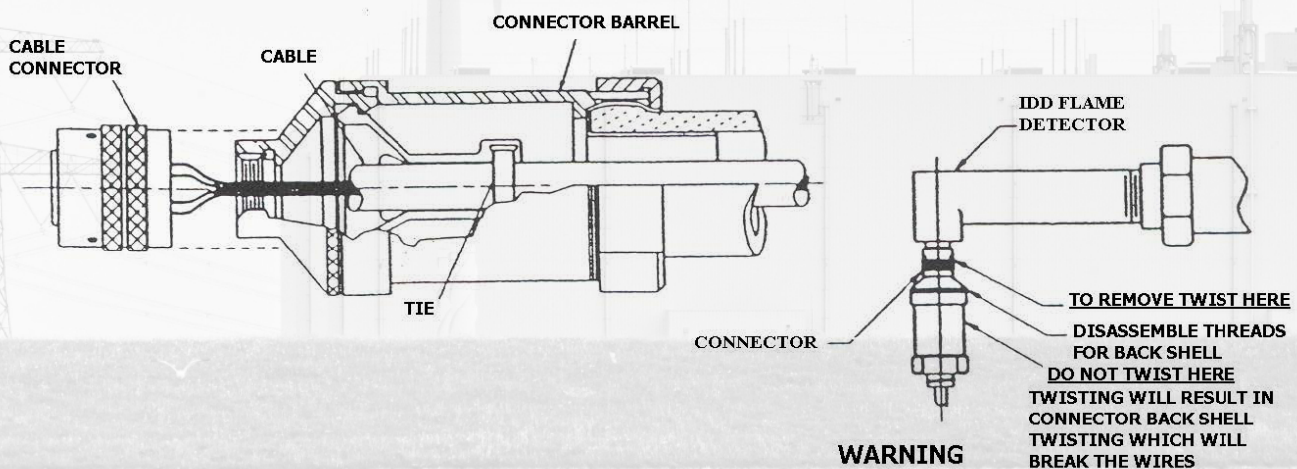
### CAUTION

The detector head contains sensitive electrical components. Ensure that all power is removed from the external amplifier assembly before connecting or disconnecting the I/O cable.



### NOTICE

Disconnect the cable from the detector by hand, but do **NOT** twist the connector barrel (figure 5). Twisting could cause the wires to become disconnected from solder connections inside the connector barrel.



**Figure 5 Cable Connections to Detector Head**  
(IDD Detector Head shown instead of UV-4 shown for illustration purposes)



# SECTION 3

## Commissioning

When installing a detector head for the first time, ensure the following requirements are satisfied:

- The physical mounts are adequate to support the weight of the detector head in the position required for operation.
- The ball valve lever of the cooling-air line moves through its entire operating range without obstruction from any structure, cable, or hose.
- The cooling-air hose and I/O cable do not interfere with the operation of any moving components at the boiler front. The I/O cable does not contact hot surfaces capable of melting its insulation.

After installation of external amplifiers for the flame detectors, perform an operational checkout as follows:

1. If the system uses rack-mounted amplifier assemblies, ensure that all power supplies for the flame detector system are adjusted to the required voltage levels.
2. Apply operating power to the external amplifier. If a dual-range amplifier assembly is being used, ensure that the UV mode of operation is selected. Verify that the voltage outputs from the amplifier are at the correct level.
3. Verify operation of the detector head as follows:
  - a. If already installed, remove the detector head and base assemblies from the furnace mounting.
  - b. Reassemble the flame detector and place a UV light source 1 to 4 feet from the surface of the lens or the end of the fiber-optic light guide.
  - c. Use an oscilloscope to measure the signal from the flame detector head at the input terminal of the external amplifier. The signal observed should be a series of digital pulses having a maximum frequency between 1 and 2 kHz.
  - d. Blind the detector cell. Verify that the external amplifier supplies +15 vdc to energize the shutter solenoid. Ensure that the output signal from the detector head is lost.
4. After checkout, return the system to normal configuration.

# SECTION 4

## Removal / Installation

The UV-4 flame detector is designed for front-mounted, direct-view, or fiber-optic sighting of the burner flame. Initial installation of a new flame detector normally is accomplished with the furnace cold and depressurized. However, failure of a flame detector during operation requires prompt replacement of the head assembly. Major considerations for removal/installation of a flame detector head during furnace operation are as follows:

1. Remove power from the external amplifier assembly for the flame detector being replaced.
2. Loosen the bolt securing the head assembly to the base assembly. Carefully disengage the mating internal connectors to remove the head assembly.
3. Perform these steps in reverse order to install a replacement head.



# SECTION 5

## Operation

The Forney UV-4 detector normally is sighted on the primary combustion zone of a burner, and light from the burner flame passes through a sight tube or a fiber-optic light guide to an opening in the base assembly housing. Because the sensor tube is positioned directly behind this opening, essentially all light enters the tube. IF the intensity of the UV light is great enough to ionize the gas in the tube, the flame detector head generates a continuous pulse train.

## 5.1 Normal Operation

Electronic components in the UV-4 flame detector PCB include a dc-dc voltage converter, RC biasing network, optocoupler, and single-shot. The external amplifier provides +14 vdc power, which is applied to all active components on the PCB. The dc-dc voltage converter boosts the input power to produce a large potential difference between the anode and cathode inside the UV sensor tube. The sensor tube contains a gas that can be ionized by absorbing energy directly from UV radiation. If the rate of ionization exceeds the rate of recombination, a surge of current passes through the tube, producing a high-voltage transient. The tube operates with a nominal 350-vdc bias voltage and requires a threshold flux of UV radiation to start conducting. Each time the tube enters the conducting state, a capacitor in the anode circuitry discharges through the cathode circuit, dropping the bias below 350 vdc. This drop in bias voltage causes the tube to stop conducting almost immediately, and the power supply begins recharging the capacitor in the anode circuit. Since the RC time constants for the anode and cathode circuits are fixed, the interval between successive discharges is directly proportional to the magnitude of UV flux incident on the tube.

Each discharge through the sensor tube produces a high-voltage pulse having a duration of no more than a few microseconds. Since the magnitude of the voltage pulse is far too great for logic circuitry, the optocoupler performs level conversion and also inverts the signal to produce a low-active trigger pulse. The leading edge of each trigger pulse then causes the single-shot to generate a digital output pulse having a fixed pulse width of 500  $\mu$ s. When considered as a function of time, the frequency of the output signal from the head is directly proportional to the intensity of UV radiant energy striking the tube.

## 5.2 Self-Test Operation

The external amplifier normally runs a self-test cycle at regular intervals under program control. At the start of each self-test cycle, the amplifier enables +15 vdc to energize the shutter solenoid, blocking the light path mechanically. The amplifier then monitors the input signal from the detector head to verify that a flame-out condition is detected. If the input signal continues to indicate flame presence for the entire test interval, the amplifier activates an alarm to indicate test failure.

# SECTION 6

## Maintenance

The only maintenance needed by the UV-4 detector head is periodic cleaning of the glass lens (direct-view configuration only). The appropriate cleaning schedule is determined by the quality and cleanliness of the cooling-/ seal-air source. Forney recommends the use of a non-oily cleaning solution and a soft lint-free cloth for lens cleaning.



# SECTION 7

## Troubleshooting

If the detector head malfunctions, ensure that the procedures described in the commissioning section have been performed successfully.

Refer to Table 1 for troubleshooting information.

**Table 1 UV-4 Flame Detector Troubleshooting**

Symptom	Probable Cause	Remedy
Signal weak or unreliable	<ol style="list-style-type: none"><li>1. Power source voltages out of adjustment.</li><li>2. Glass lens dirty.</li><li>3. UV sensor tube or electronics defective.</li></ol>	<ol style="list-style-type: none"><li>1. Adjust power supply voltage levels as required (units with rack-mounted amplifier assemblies only)</li><li>2. <i>Clean glass lens.</i> Use a non-oily lens cleaner and soft cloth to avoid scratching the glass.</li><li>3. <i>Replace detector head.</i> Return unit for repair or replacement.</li></ol>
No signal output	<ol style="list-style-type: none"><li>1. Supply voltage to head not present</li><li>2. Detector head assembly not functional.</li><li>3. Overheated detector head.</li></ol>	<ol style="list-style-type: none"><li>1. Verify that external amplifier is supplying the correct voltages for the selected operating mode.</li><li>2. Replace detector.</li><li>3. Check the surface temperature of the detector. If the temperature is greater than 160° F, check for inadequate cooling-air flow.</li></ol>
Check alarm	Noise on output signal	<ol style="list-style-type: none"><li>1. Ensure that I/O cable wires are securely attached to terminals on the external amplifier.</li><li>2. Check for broken cable wire.</li><li>3. Reroute cable if not in a shielded cable tray.</li><li>4. Replace detector.</li></ol>

# SECTION 8

## Storage

Store the UV-4 Detector in its shipping box until used. See the mechanical specifications for storage temperature ranges.



# SECTION 9

## Return or Repair Service

Forney Corporation warrants this product to be free of defective material and workmanship. Forney will repair or replace this equipment if it is found to be defective upon receipt, but not later than 90 days from the date of shipment.

Prior to returning any material to Forney, please contact your Forney customer service representative and provide the contract number or the customer purchase order number.

Contact Forney's Aftermarket Department via any one of the following methods and furnish the following information.

E-mail	Phone	Fax
<a href="mailto:spares@forneycorp.com">spares@forneycorp.com</a>	972-458-6100 or 972-458-6142 or 1-800-356-7740 (24-hour direct line)	972-458-6600

1. Contract number
2. Customer purchase order number
3. For each part ordered, provide the following information:
  - a. Part number
  - b. Part description
  - c. Quantity required