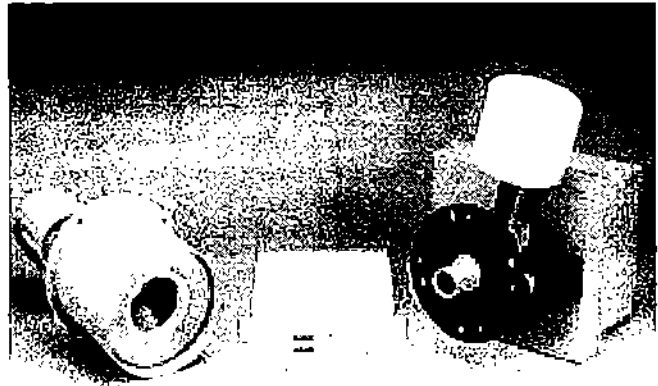


## Model 5100A

# Carbon Monoxide (CO) Analyzer

- Dual Microprocessor-Based
  - Exceptionally easy to operate
  - Control room access to all analyzer functions
  - Programmable operating parameters for varying boiler operating conditions
- Control Room Diagnostic Capability
  - Alerts operator to preventative maintenance requirements
  - Eliminates costly unscheduled maintenance
- Rugged, Infrared Source Design
  - Contains no focusing optics, eliminates vibration sensitivity and precise alignment procedures
- Sturdy, Reliable Receiver Design
  - 185°F(85°C) electronics, non-cooled detector assure stable performance at high ambient temperature
  - NEMA 4X(IP56) enclosure for harsh industrial environments
- Completely Automatic Zero/Span Calibration
  - Assures continuously reliable data without operator intervention
  - Internal standards eliminate need for external calibration devices
- In Situ Analysis
  - Representative across-duct measurement, free from stratification errors
  - Eliminates sampling system maintenance



## INTRODUCTION

The importance of controlling excess air levels in various combustion processes has been recognized for many years. Now, however, the high cost of fuel makes it an economic necessity to reduce excess air levels to minimize thermal stack losses. Efforts toward combustion efficiency optimization must be aimed at reducing total energy loss. This requires achieving minimum unburned combustible, as well as thermal stack losses. More precise control of air/fuel ratio, optimized for minimum total energy loss, can yield significant gains in efficiency and result in substantial savings in reduced fuel consumption.

Flue gas concentration of carbon monoxide is a reliable and accurate indication of burner flame stoichiometry and the completeness of combustion. It is the most sensitive indicator of unburned combustibles loss. Used as a primary combustion efficiency parameter, in conjunction with oxygen analysis, carbon monoxide offers significant advantages in controlling combustion at optimum levels of excess air. Controlling air/fuel ratio to an optimum level of carbon monoxide assures minimum total energy loss and maximum efficiency, independent of variations in boiler load, fuel type and fuel quality. The measurement is relatively unaffected by air in-leakage and burner maintenance requirements are immediately identified.

Rosemount Analytical's innovative technology, coupled with small, lightweight packaging and ease of operation and maintenance, assures you of years of trouble-free service from the Model 5100A CO Analyzer.

**ROSEMOUNT**  
Analytical

Visit our website at [www.processanalytic.com](http://www.processanalytic.com)  
On-line ordering available.

  
**EMERSON**  
Process Management

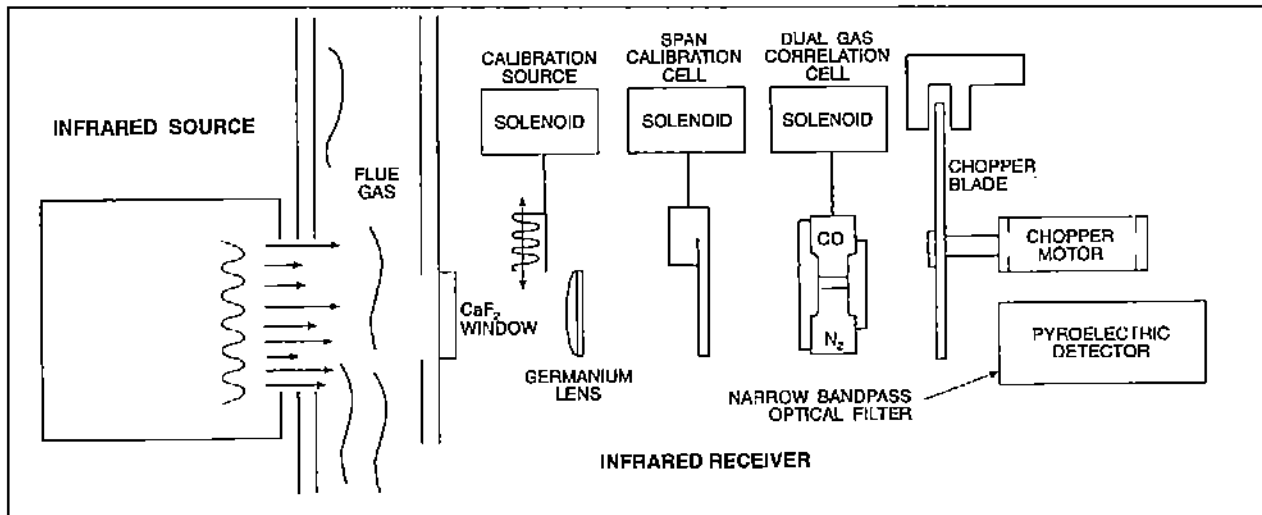


Figure 1. Optical Diagram

The Model 5100A CO Analyzer sets superior standards of quality and reliability in providing the many benefits of continuous flue gas carbon monoxide measurement.

## PRINCIPLE OF OPERATION

The Model 5100A utilizes infrared absorption spectroscopy to continuously measure CO concentration in combustion flue gases. The infrared source is mounted directly on the flue gas duct or stack on the side opposite from the receiver. Infrared energy is radiated by the source, through the flue gas, to the receiver. The receiver employs gas filter correlation and narrow bandpass optical filtration with a solid state detector to determine the absorption of radiation by CO in the flue gas.

These principles are illustrated in block diagram form in Figure 1. Infrared energy, radiated by the source, passes through the flue gas, where a portion of the energy is absorbed by any CO present. The remaining energy passes through the receiver window, focusing lens and, alternately, through two gas cells. One of the two cells is filled with CO, the other, nitrogen. These are inserted alternately in the optical path at a fixed frequency. Energy at the wavelengths of interest is, effectively, fully absorbed in the CO reference cell; however, energy is transmitted through the nitrogen cell without further absorption. After passing through the narrow bandpass filter, the remaining energy impinges upon the detector. Two energy levels are sensed alternately by the detector: source radiation reduced by the flue gas and reference cell CO and source radiation reduced by flue gas CO only. The resulting signals are ratioed and compared with the ratioed signals developed under zero CO calibration conditions. The comparative difference in ratios is used to compute flue gas CO concentration.

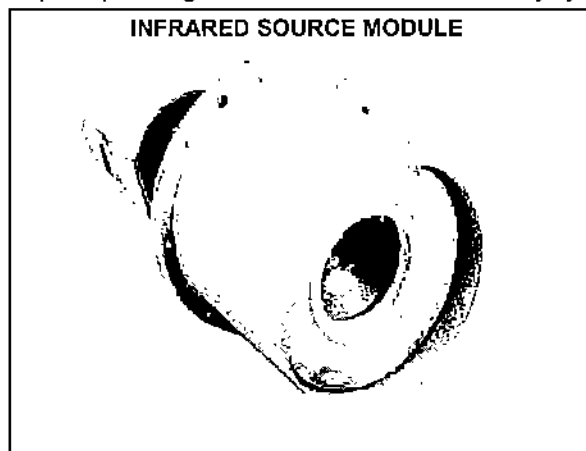
The calibration source and span calibration cell are inserted into the optical path during automatic zero and span calibration of the instrument.

The design of the infrared source module is unique to the Model 5100A and offers benefits which are not available with conventional infrared sources used in other in situ CO instrumentation.

The infrared source module emits broadband infrared radiation, including the waveband of interest, from 4.5 to 4.9 microns. The source consists of a four-inch diameter stainless steel body with a conical surface for uniformity of surface temperature and maximum emissivity. The source is heated to a temperature of 1,112°F (600°C) and is controlled at this temperature to assure constant intensity. The source is fully insulated and enclosed in a carbon steel mounting sleeve designed for welding directly to the duct.

Since the IR source module is installed such that the source surface is flush with the inner wall of the duct, the source is not subject to coating or particulate buildup in most applications. Consequently, there is no purge air requirement to maintain source cleanliness. Due to the large diameter of the source surface, focusing is not required, and the source contains no focusing optics whatsoever. An added benefit of the large diameter source is insensitivity to duct vibration and elimination of the need for constant realignment otherwise required of focused systems.

Maintaining the source temperature at 1,112°F (600°C) requires powering the heater at a nominal 50% duty cycle,



## INFRARED SOURCE MODULE

extending the heater element life considerably. The

operating life of the infrared source is approximately four times that of conventional infrared sources.

## INFRARED RECEIVER MODULE

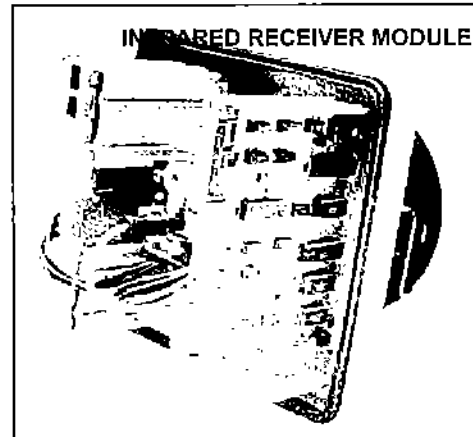
The infrared receiver module is designed to house the optics, detector and necessary electronics and hardware to determine absorption of infrared radiation emitted by the infrared source module. Designed for ease of installation, the receiver weighs only 33 pounds (15.0 kg) and mounts to a standard ANSI four-inch, 150-pound weld neck flange (DIN STD 25 kg/cm<sup>2</sup> 100 mm). The receiver is housed in a NEMA 4, epoxy coated, mild steel enclosure to withstand harsh industrial environments.

The calcium fluoride window, which protects the receiver from intrusion of flue gases, is mounted on a slider assembly and can be easily removed in the field for cleaning without disturbing the mounting of the receiver.

Alignment with the infrared source module is exceptionally simple, taking just 15 minutes on the average. The operator is guided by an innovative audio-visual system in the receiver. A column of sequentially illuminated LED's, in combination with audible, peaking tones, virtually tells the operator when he has achieved proper alignment. Once aligned, operation is completely controlled by the receiver CPU, communicating with the control module CPU. Communication between the receiver and the control module is RS-422, over three-conductor, shielded cable.

Unlike conventional in situ CO instrumentation employing thermoelectrically cooled, photoconductive detectors, the receiver employs a non-cooled pyroelectric detector. Not only does this provide reliable, stable performance at a high ambient temperature, it completely eliminates the maintenance associated with thermoelectric cooling systems. Further high temperature stability is afforded by the use of 185°F (85°C) electronics.

The complete optical bench assembly is slide-rail mounted and is removable as a unit. All components of the assembly are accessible and may be serviced or replaced individually.



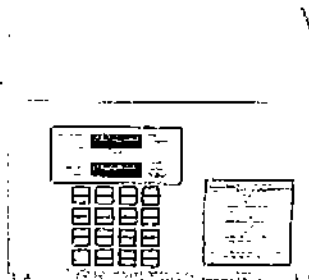
## CONTROL MODULE

The Model 5100A microprocessor-based control module provides the operator with convenient access to all functions of the CO analyzer. The simple 16-key, dual-function keyboard allows the user to input all variable operating parameters from the control room. It also provides instant, single keystroke access to all normally used functions without the need for specialized training.

Several sets of programmable operating parameters may be stored in the failsafe EEPROM memory to accommodate varying boiler conditions. In the event of a power outage, all stored values are retained without battery backup. When power is restored, normal operation will automatically resume without operator intervention.

Once operator-selected values are input, all computational and diagnostic routines are completely microprocessor controlled. Computational routines include: carbon monoxide concentration in ppm, optical path length compensation, linearization of detector output and automatic compensation for flue gas, receiver optics and electronics temperature variations.

## CONTROL MODULE DISPLAY/KEYBOARD



- All functions accessible through control room keyboard/display
- Sophisticated diagnostics alert operator to maintenance requirement and any software or hardware failures
- Operator programmable parameters for varying boiler operating conditions
- Plug-in printed circuit boards for ease of maintenance
- LCD display provides direct reading in engineering units, U.S. Standard or metric
- Indication includes measured data, all operating parameters and all alarm or error conditions
- Tactile, audio feedback keystrokes
- Function/second function keys minimize keystrokes

Diagnostic routines include, among many others: automatic zero and span calibration, continuous microprocessor self-interrogation of memory/software and hardware/mechanical functioning status. Diagnostics are so comprehensive that they will alert the operator to preventative maintenance requirements; so intelligent that they will differentiate between a dirty window or low source intensity. No scheduled routine maintenance is required.

All measured data, operating parameters and fault or error conditions are indicated on the easy-to-read, dual LCD display. Readout is provided in engineering units, metric or U.S. Standard, at the operator's choice.

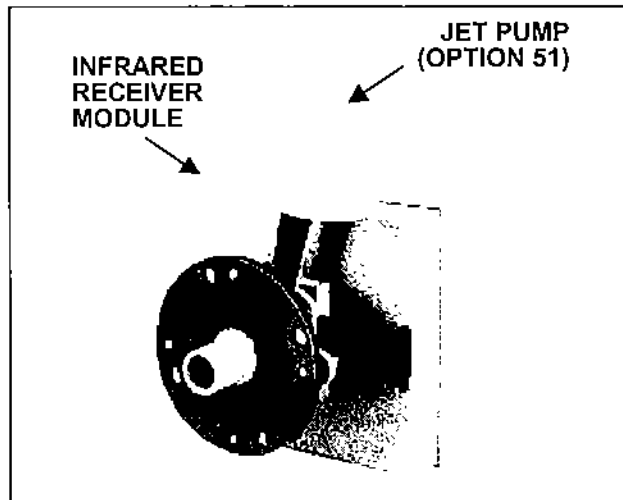
In the event of a disabling fault or error condition, the Model 5100A will automatically "hold" the output at the last valid measured CO value. A held output condition is also generated during automatic calibration cycles of the instrument.

The Model 5100A control module is conveniently packaged in a lightweight, compact (5.22 x 10.61 inches/132 x 269 mm), DIN-size enclosure with panel mount hardware. A single, three-conductor, shielded cable is all that is required to complete interconnection between the receiver and the control room, further minimizing installation costs.

All printed circuit boards in the Model 5100A are modular "plug-in", for ease of access and field replacement, if required. All internal wiring and customer interconnections utilize modular plugs and DIN-style connectors, completely eliminating problems associated with "hard wired" circuitry.

## FLUE GAS TEMPERATURE MEASUREMENT

The absorption of infrared radiation by carbon monoxide in combustion flue gases is a function of flue gas temperature. The temperature affects the density of the gas and, therefore, the number of molecules encountered by the radiation. In addition, temperature variations induce variations in the infrared absorption characteristics of carbon monoxide. To account for these variations, flue gas temperature must be measured continuously. The Model 5100A is provided with a separate, direct-insertion thermocouple for this purpose. Temperature data is input to the receiver module and communicated to the control module. The control module software is fully characterized to provide accurate temperature compensation over the full flue gas temperature range of 200°F to 600°F (93°C to 316°C).



## PURGE AIR REQUIREMENTS

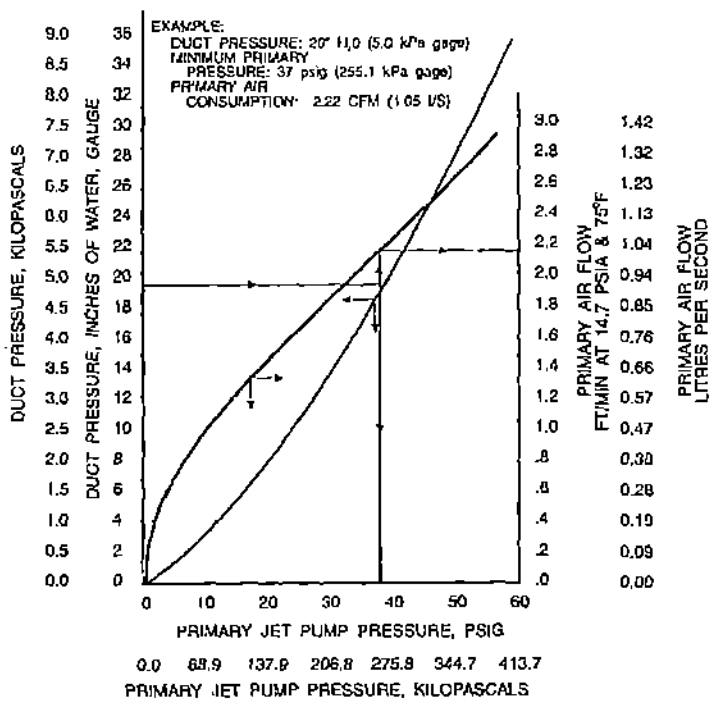
The Model 5100A is designed to provide continuous, reliable operation, while minimizing the necessary utilities requirements to do so. Supplying plant air is costly and the Model 5100A minimizes its consumption or eliminates it completely. The infrared source module requires no purge air in many applications. Purge air may, however, be required to maintain receiver window cleanliness. The optional jet pump (option 51) of the Model 5100A was designed with this requirement in mind. In negative duct pressure applications, ambient air is naturally drawn into the jet pump, filtered, passed through the purge assembly and into the duct. No external air supply is required. In positive duct pressure applications, pressurized, low volume plant air is supplied to the jet pump to induce a low-pressure, high-volume flow of ambient purge air through the purge assembly. If plant air is not conveniently available, the Model 5100A may be provided with an optional air blower accessory. Regardless of the user's choice, plant air requirements are kept at an absolute minimum.

### CAUTION

The air blower accessory or plant air must be provided if pressure in the duct is not always a negative pressure. Failure to do so may allow high internal temperatures to be reached in the infrared receiver causing damage to the equipment or shorten its operational lifespan.

## AIR PURGE PRESSURE AND FLOW REQUIREMENTS FOR MODEL 5100A CO ANALYZER

FOR MAXIMUM EXPECTED DUCT PRESSURE, SET  
PRIMARY PRESSURE AT INDICATED VALUE OR HIGHER



### SOURCE PURGE AIR ASSEMBLY

The infrared (IR) source module is installed with the source surface flush against the inner wall of the duct in most applications. Therefore, the source is subject to only minimal coating or particulate buildup and consequently, there is no purge air requirement to maintain source cleanliness. However, in certain applications such as Kraft recovery units and some waste incinerators, the flue gases contain constituents which can adhere to the source (despite the high surface temperature) and damage the source through corrosion. In these applications, to protect the source and reduce the need for periodic manual cleaning of the source surface (to maintain radiated intensity for proper analyzer operation), a source air purge is required.

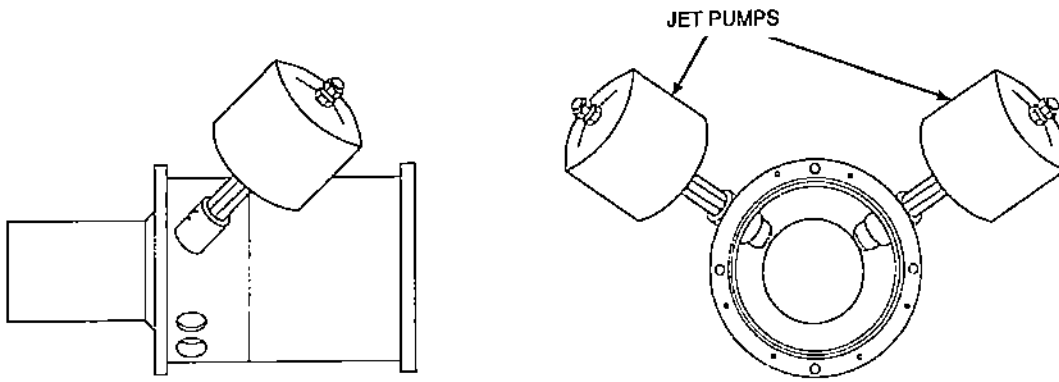
The source purge air assembly with jet pumps (option 53) consists of a carbon steel sleeve fitted with two jet pumps, one on either side as shown on page 6. These jet pumps are identical to that used with the IR receiver module with the exception of being equipped without filters. The purge assembly is installed on the standard source mounting sleeve and the

source module is then installed in the purge assembly. Procedures and hardware for installing the source module in the purge assembly are identical to those for installation in the standard mounting sleeve.

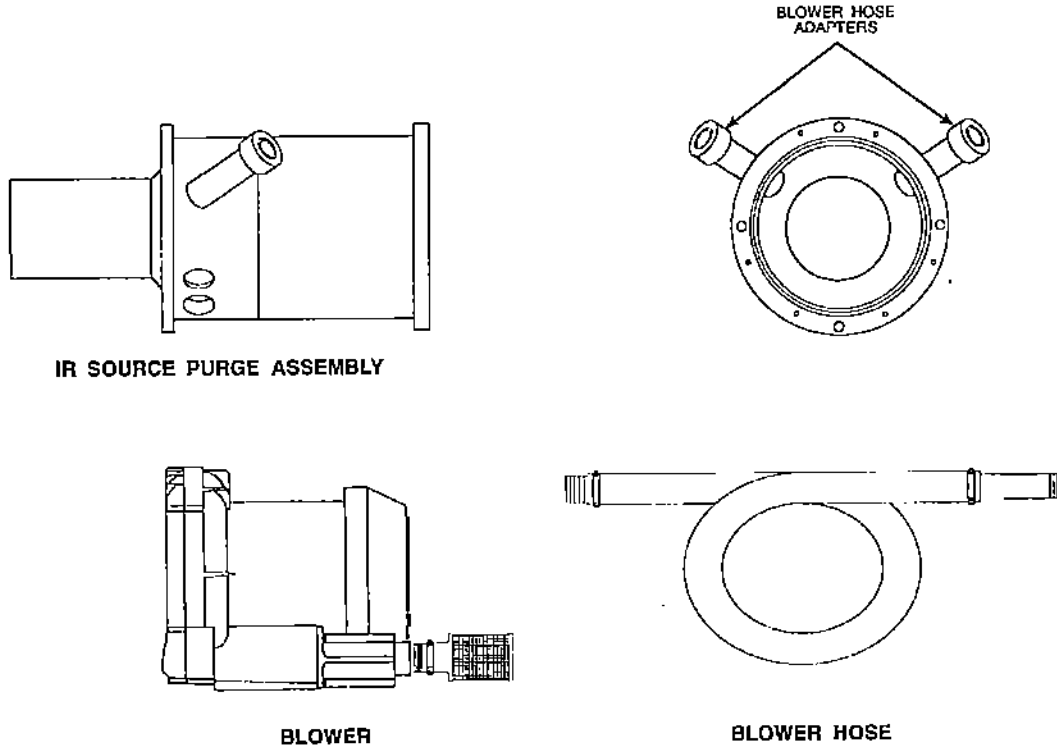
When installed, the source surface is recessed from the duct wall at the rear of the cavity created by the mounting sleeve and the active forward section of the purge assembly. A user supplied compressed air source is connected to the 1/4-inch tube fitting on each jet pump. Compressed air requirements are 6 SCFM (2.7 l/s) at 60 psig (413.7 kPa), 3 SCFM (1.35 l/s) at each fitting. The jet pump is designed to accept the compressed air and induce a low pressure, high volume flow of ambient air through the purge assembly. The two jet pumps produce properly directed flows of sufficient volume to effectively purge the cavity, shielding the source from the flue gases.

The source purge air assembly with blower (option 55) may be used when compressed air is not available for the jet pumps (option 53).

**SOURCE PURGE AIR ASSEMBLY WITH JET PUMPS  
(OPTION 53)**

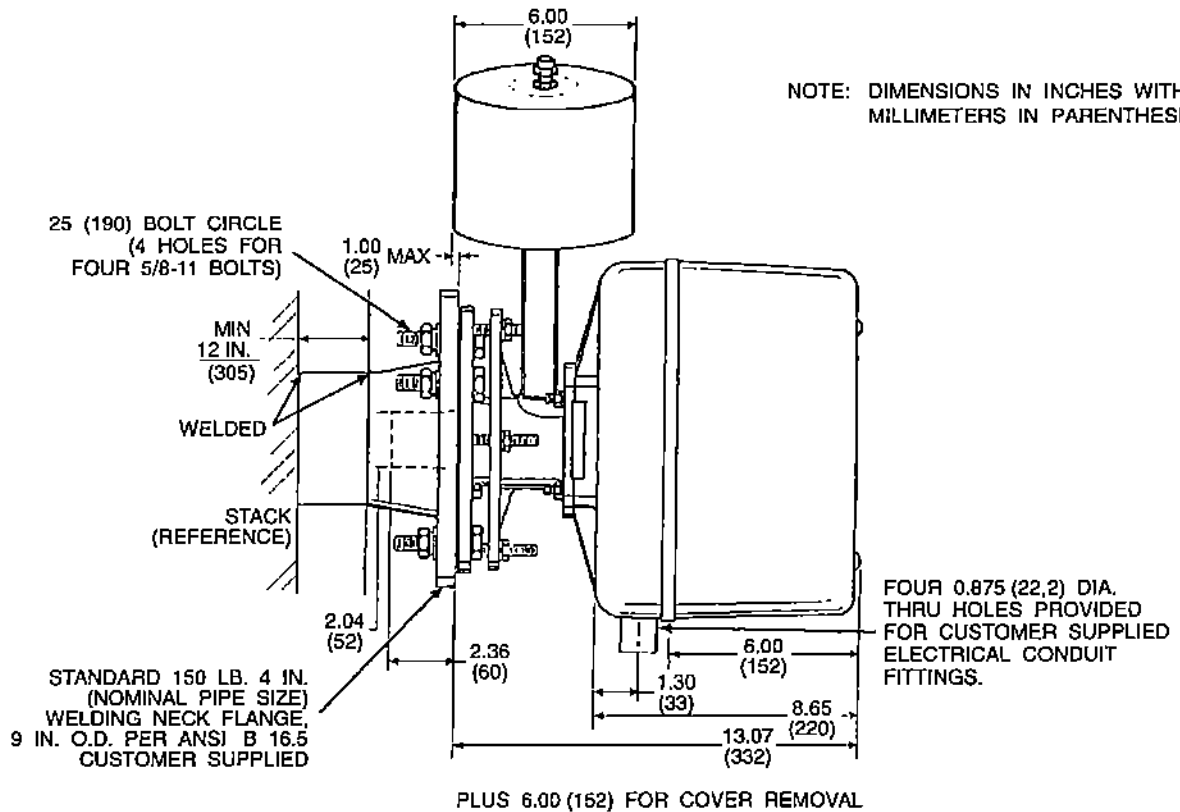


**SOURCE PURGE AIR ASSEMBLY WITH BLOWER  
(OPTION 55)**

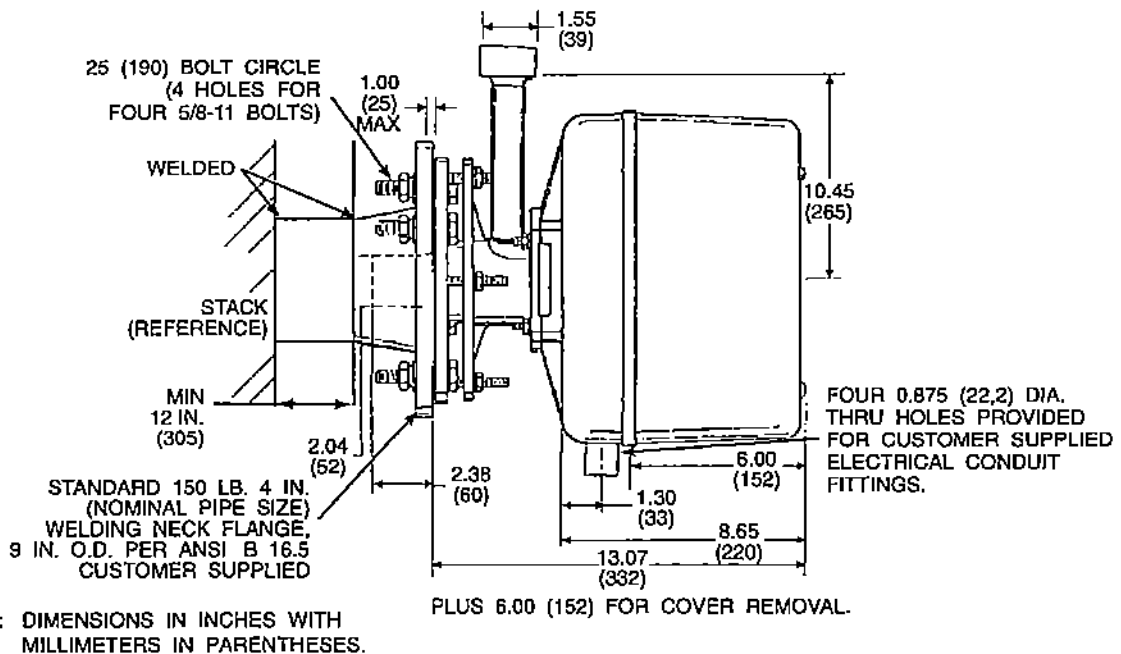


# MOUNTING DIMENSIONS

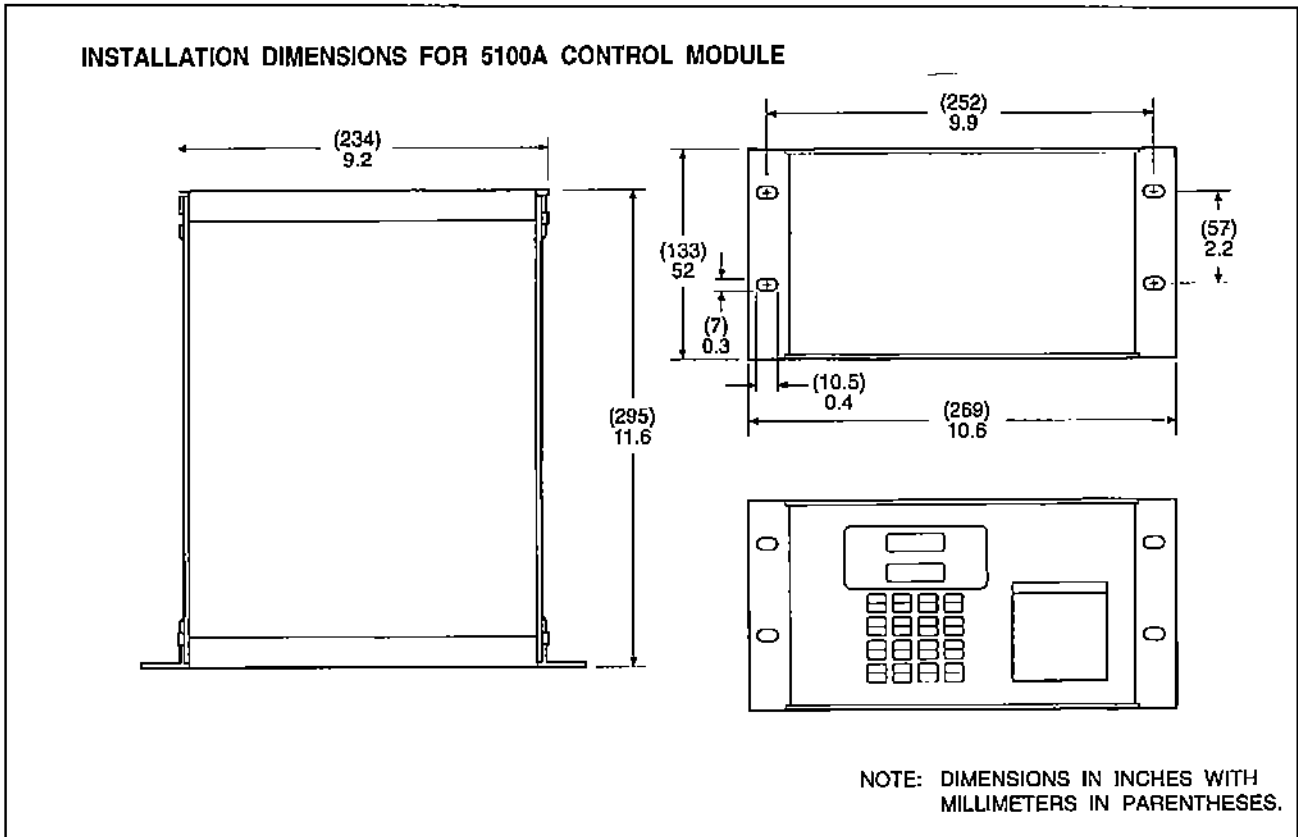
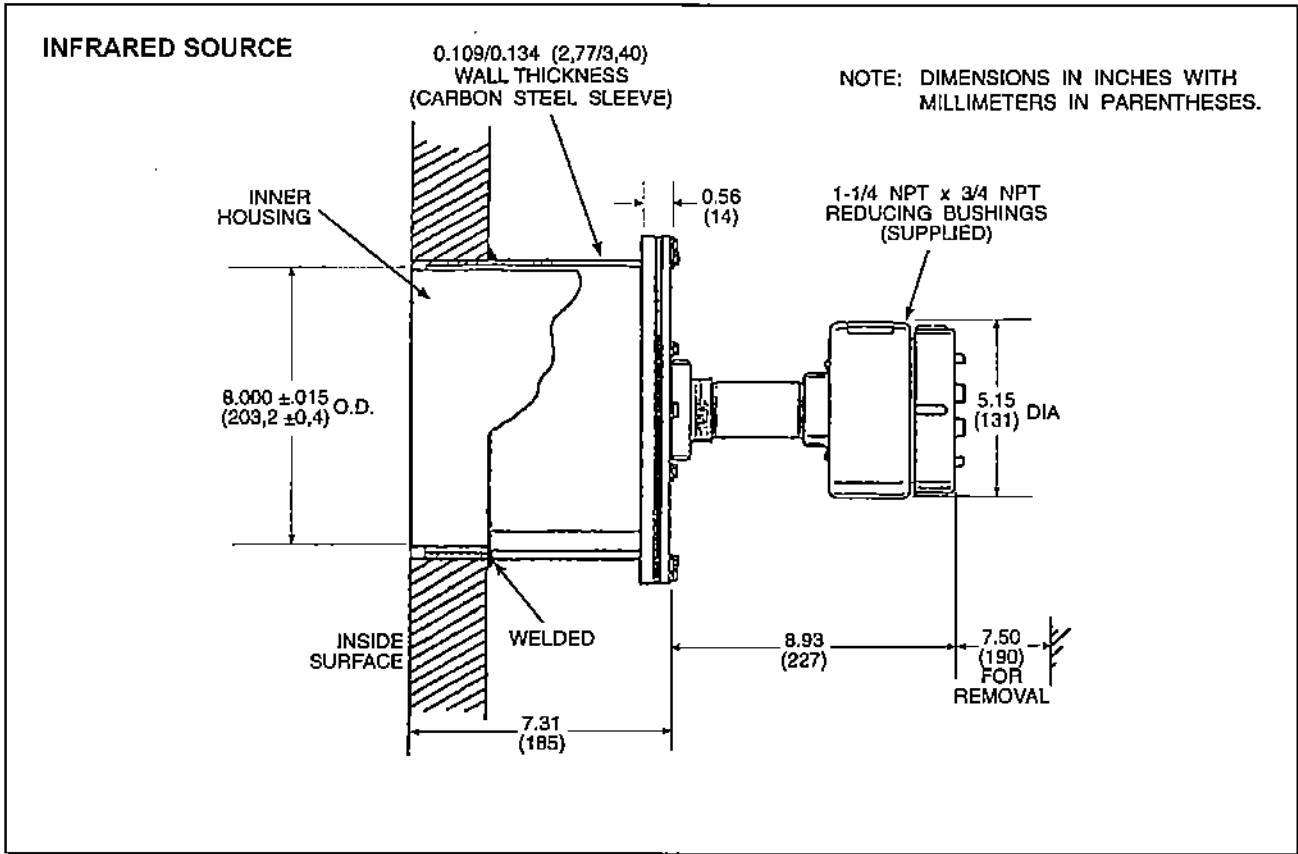
## INFRARED RECEIVER WITH JET PUMP (OPTION 51)



## INFRARED RECEIVER WITH BLOWER ADAPTOR (OPTION 52)



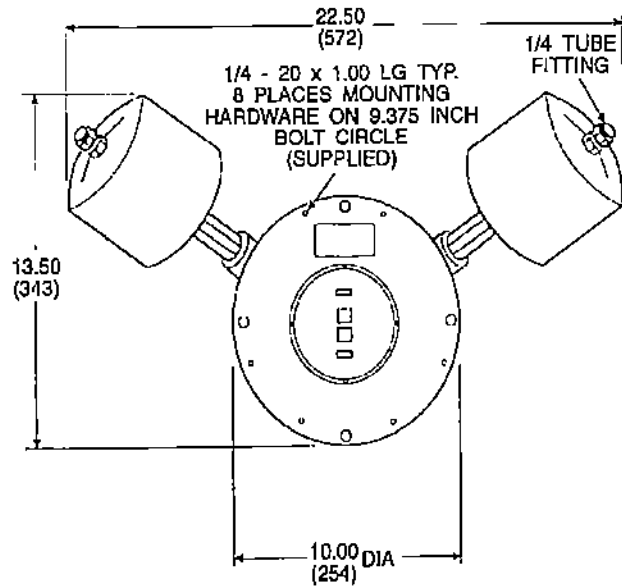
# MOUNTING DIMENSIONS (CONTINUED)



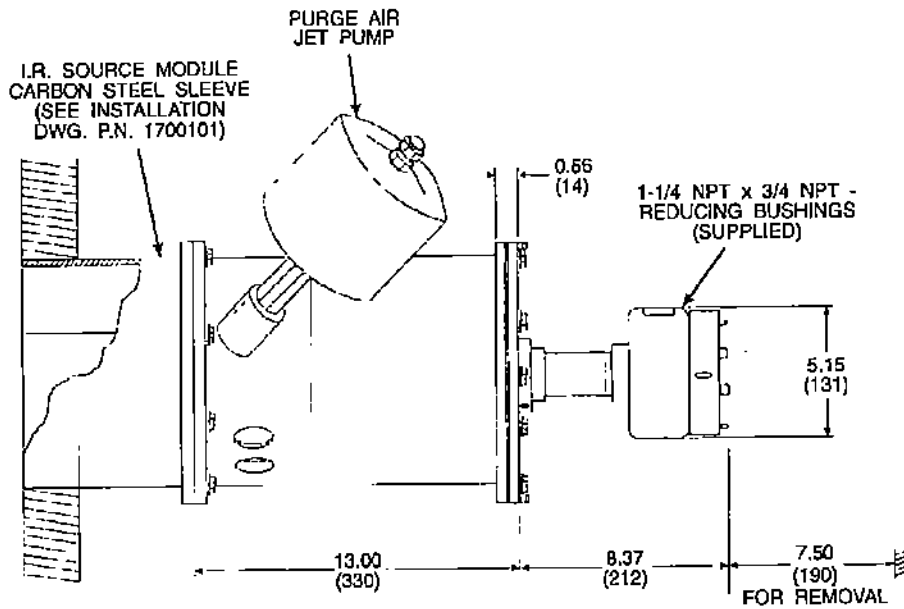


# MOUNTING DIMENSIONS (CONTINUED)

## SOURCE PURGE AIR ASSEMBLY WITH JET PUMPS (OPTION 53)



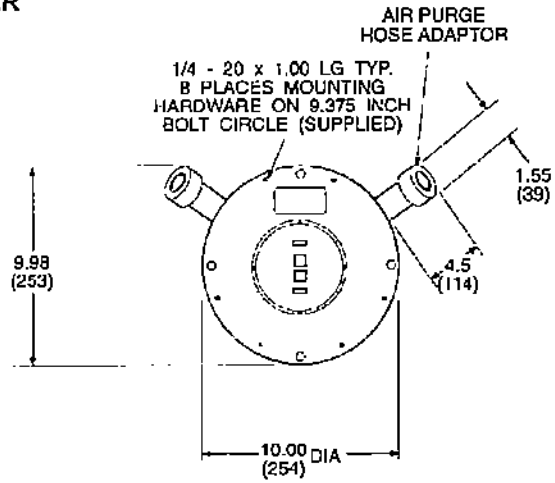
NOTE: DIMENSIONS IN INCHES WITH  
MILLIMETERS IN PARENTHESES.



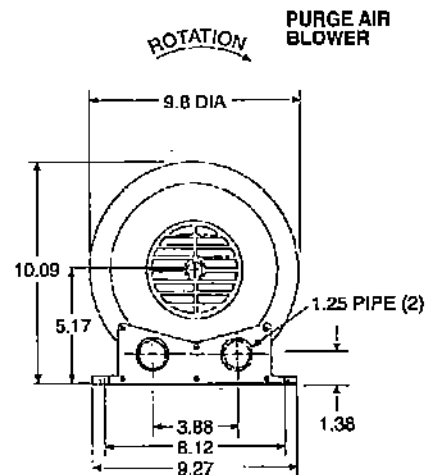
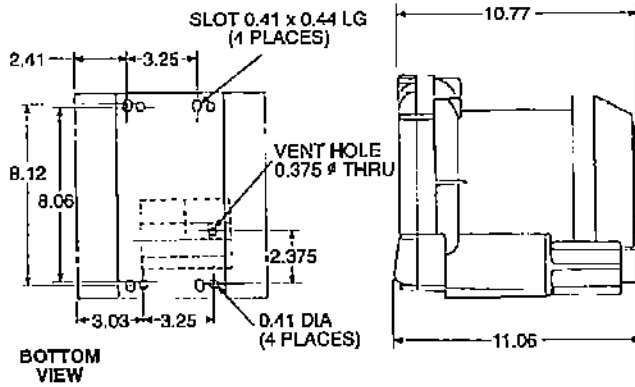
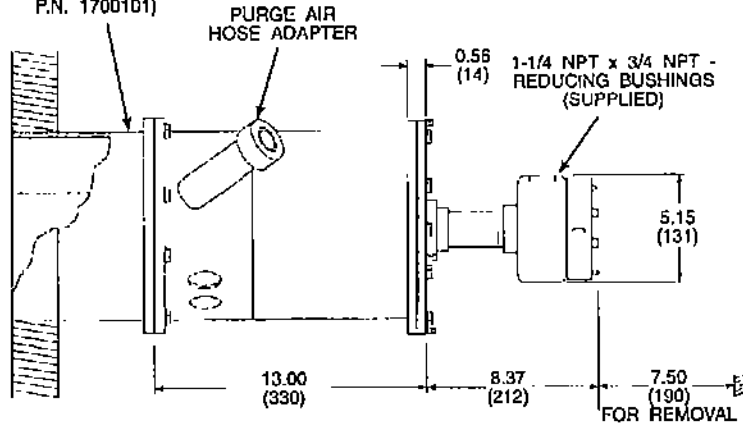
# MOUNTING DIMENSIONS (CONTINUED)

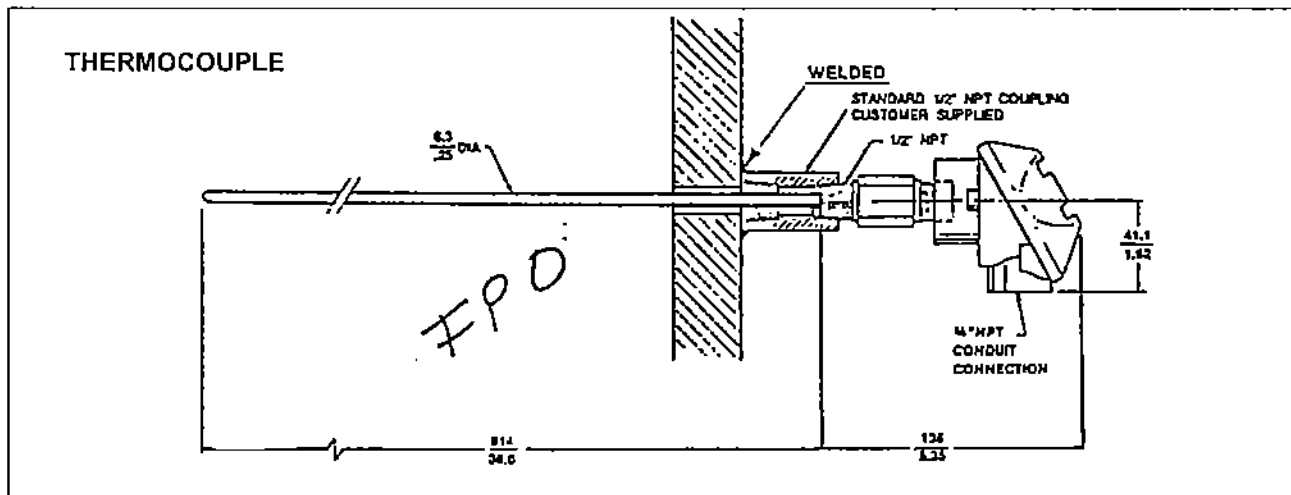
## SOURCE PURGE AIR ASSEMBLY WITH BLOWER (OPTION 55)

NOTE: DIMENSIONS IN INCHES WITH MILLIMETERS IN PARENTHESES.



I.R. SOURCE MODULE  
CARBON STEEL SLEEVE  
(SEE INSTALLATION DWG.  
P.N. 1700101)





## MODEL 5100A ANALYZER SPECIFICATIONS

### PERFORMANCE

|                                 |   |
|---------------------------------|---|
| Measuring range:                | Continuously adjustable,<br>0-200 to 0-10,000 ppm/m |
|                                 | CO (Optical path length dependent)                  |
| Accuracy:                       | ±20 ppm plus ±6% of reading                         |
| Repeatability:                  | ±10 ppm plus ±3% of reading                         |
| Time constant:                  | Continuously adjustable, 5-255 sec.                 |
| Discrimination ratio:           | CO <sub>2</sub> : CO, minimum 10,000:1              |
| Water Vapor:                    | CO, minimum 10,000:1                                |
| Distance source<br>to receiver: | 1.5 to 40 ft. (0.46 to 12.2m)                       |

### INFRARED RECEIVER MODULE

|                       |  |
|-----------------------|--|
| Enclosure:            | NEMA 4X (IP56) epoxy coated steel  |
| Weight:               | 33 lbs (15.0 kg)   |
| Mounting:             | ANSI 4-inch, 150 lb weld neck<br>flange<br>(DIN STD 25 kg/cm <sup>2</sup> 100 mm)<br>(customer supplied) |
| Ambient temperature:  | -20° to 130°F (-29° to 54°C)   |
| Flue gas temperature: | 200° to 600°F (93° to 316°C)   |
| Detection method:     | Infrared absorption, gas filter<br>correlation, narrow bandpass<br>optical filtration                    |
| Power requirements:   | 100 to 130/200 to 260 Vac, 50/60<br>Hz nominal 125 watts   |
| Signal output:        | RS-422 transmission  |

### INFRARED SOURCE MODULE

|                        |  |
|------------------------|--|
| Enclosure:             | Stainless steel, carbon steel, cast<br>aluminum                              |
| Weight:                | 33 lbs (15.0 kg)   |
| Mounting:              | 8-inch (203 mm) Sch. 5S carbon<br>steel mounting sleeve                      |
| Ambient temperature:   | -20° to 130°F (-29° to 54°C)   |
| Operating temperature: | Nominal 1,112°F (600°C)  |
| Power requirements:    | 100 to 130/200 to 260 Vac, 50/60<br>Hz nominal 550 watts, max. 1300<br>watts |

### FLUE GAS SENSOR

|                  |   |
|------------------|---|
| Sensor:          | Thermocouple, Type K chromel-<br>alumel |
| Sheath material: | Inconel                                 |
| Mounting:        | 1/2 inch (1.3 cm) NPT                   |

### CONTROL MODULE

|                      |  |
|----------------------|--|
| Enclosure:           | General purpose, half-width eurorack   |
| Weight:              | 9 lbs (4.08 kg)  |
| Mounting:            | Rack or panel mount, DIN standard  |
| Dimensions:          | 5.22 x 10.61 x 13.61 in.<br>(132.5 x 269.5 x 298 mm)(H x W x D)  |
| Ambient temperature: | 32° to 104°F (0° to 40°C)  |
| Readout:             | Dual LCD display   |
| Analogue output:     | 4 to 20 mA dc, 0 to 20 mA dc<br>(600 ohms max. load)<br>0 to 5 Vdc, 1 to 5 Vdc<br>(1000 ohms min. load)<br>Isolated, field selectable  |
| Alarms:              | Two (2) high/low alarms, solid state<br>relays, rated 3 amp, ac<br>One (1) composite alarm relay,<br>SPDT: 780 VA inductive, 260 volts |
| Power requirements:  | 100 to 130/200 to 260 Vac, 50/60 Hz,<br>20 watts   |
| Electrical noise:    | Meets EMC requirements   |

### PURGE AIR BLOWER - OPTIONAL

|                     |  |
|---------------------|--|
| Horsepower:         | 1/2  |
| Power Requirements: | 115/208 to 230 Vac, 60 Hz, 400 watts<br>110/220 to 240 Vac, 50 Hz, 400 watts |
| Air flow (max):     | 43 SCFM at 50 Hz<br>53 SCFM at 60 Hz   |
| Dimensions:         | 10.1 x 9.7 x 11.1 inches<br>(274 x 246 x 281 mm)                             |
| Shipping weight:    | 29 lbs (13.2 kg)   |



Fisher-Rosemount has satisfied all obligations coming from the European legislation to harmonize the product requirements in Europe.

© Specifications are subject to change without notification. Our policy is one of continuous product improvement, and we reserve the right to change specifications.

## ORDERING INFORMATION

The Model 5100A CO Analyzer includes infrared source module, infrared receiver module, control module, and flue gas temperature probe. Optional air blower need only be ordered if customer supplied plant air source is not available.

|              |  |  |   |    |    |         |
|--------------|--|--|---|----|----|---------|
| <b>5100A</b> | <b>Model 5100A - CO Monitor (Base)</b> |  |   |    |    |         |
|              | <b>Code</b>                            | <b>Power Requirements (Required Selection)</b> |   |    |    |         |
|              | 1                                      | 115 Vac, 50/60 Hz                              |   |    |    |         |
|              | 2                                      | 230 Vac, 50/60 Hz                              |   |    |    |         |
|              |  | <b>Code</b>                                    | <b>Control Module Display/Keypad (Required Selection)</b> |    |    |         |
|              |  | 1  | English   |    |    |         |
|              |  | 2  | Italian   |    |    |         |
|              |  | 3  | French  |    |    |         |
|              |  | <b>Code</b>                                    | <b>Purge Options - Receiver</b>                           |    |    |         |
|              |  | 51   | Jet pump <sup>6</sup>                                     |    |    |         |
|              |  | 52   | Air blower  |    |    |         |
|              |  | <b>Code</b>                                    | <b>Purge Options - Source</b>                             |    |    |         |
|              |  | 00   | None  |    |    |         |
|              |  | 53   | Air purge assembly with jet pumps                         |    |    |         |
|              |  | 55   | Air purge assembly with blower                            |    |    |         |
|              |  | <b>Code</b>                                    | <b>Unit Identification</b>                                |    |    |         |
|              |  | 00   | None  |    |    |         |
|              |  | 54   | Stainless steel lag (specify marking)                     |    |    |         |
| 5100A        | 1                                      | 1  | 52  | 00 | 54 | EXAMPLE |

|             |  |
|-------------|--|
| <b>Code</b> | <b>Accessories</b>   |
| 9200177     | Interconnect cable, infrared receiver module to control module, 3 conductor, shielded, 22 AWG  |
| 9200178     | Thermocouple wire, Type K 24 AWG, infrared source module to infrared receiver module and flue temperature probe to infrared receiver module. |

For field service engineering assistance for startup Consult factory

Please specify if the Source Installation Kit P/N 22880-00 should:

- (A) Ship with Model 5100A  
 (B) Ship early to customer by \_\_\_\_\_ (date)

**Notes:**

- Stack or duct size for CO Monitor path length: minimum 1.5 feet (0.46m), maximum 40 feet (12 m)
- Flue gas temperature, maximum, maximum 600°F (316°C)
- Flue gas temperature, minimum 225°F (107°C)
- Flue gas pressure, maximum 28 inches (71 cm) water column
- Flue gas opacity, maximum 30%
- Customer must supply source of primary air to the jet pump

*The contents of this publication are presented for informational purposes only, and while every effort has been made to ensure their accuracy, they are not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. All sales are governed by our terms and conditions, which are available on request. We reserve the right to modify or improve the designs or specifications of our products at any time without notice.*

**Emerson Process Management**

Rosemount Analytical Inc.  
 Process Analytic Division  
 1201 North Main Street  
 P.O. Box 901  
 Orrville, OH 44667-0901 USA  
 T (330) 682-9010  
 Toll Free in US and Canada 1-800-433-6076  
 F (330) 684-4434  
 e-mail: gas.csc@EmersonProcess.com  
 www.processanalytic.com

