Model 868
Non-Dispersive Infrared Analyzer
ESSENTIAL INSTRUCTIONS
READ THIS PAGE BEFORE PROCEEDING!

Rosemount Analytical designs, manufactures and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you MUST properly install, use, and maintain them to ensure they continue to operate within their normal specifications. The following instructions MUST be adhered to and integrated into your safety program when installing, using, and maintaining Rosemount Analytical products. Failure to follow the proper instructions may cause any one of the following situations to occur: Loss of life; personal injury; property damage; damage to this instrument; and warranty invalidation.

- Read all instructions prior to installing, operating, and servicing the product.
- If you do not understand any of the instructions, contact your Rosemount Analytical representative for clarification.
- Follow all warnings, cautions, and instructions marked on and supplied with the product.
- Inform and educate your personnel in the proper installation, operation, and maintenance of the product.
- Install your equipment as specified in the Installation Instructions of the appropriate Instruction Manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- To ensure proper performance, use qualified personnel to install, operate, update, program, and maintain the product.
- When replacement parts are required, ensure that qualified people use replacement parts specified by Rosemount. Unauthorized parts and procedures can affect the product’s performance, place the safe operation of your process at risk, and VOID YOUR WARRANTY. Look-alike substitutions may result in fire, electrical hazards, or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place, except when maintenance is being performed by qualified persons, to prevent electrical shock and personal injury.

The information contained in this document is subject to change without notice.

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SNOOP® is a registered trademark of NUPRO Co.
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PREFACE

The purpose of this manual is to provide information concerning the components, functions, installation and maintenance of the Model 868 Non-Dispersive Infrared Analyzer.

Some sections may describe equipment not used in your configuration. The user should become thoroughly familiar with the operation of this module before operating it. Read this instruction manual completely.

DEFINITIONS

The following definitions apply to DANGERS, WARNINGS, CAUTIONS and NOTES found throughout this publication.

DANGER

Highlights the presence of a hazard which will cause severe personal injury, death, or substantial property damage if the warning is ignored.

WARNING

Highlights an operation or maintenance procedure, practice, condition, statement, etc. If not strictly observed, could result in injury, death, or long-term health hazards of personnel.

CAUTION

Highlights an operation or maintenance procedure, practice, condition, statement, etc. If not strictly observed, could result in damage to or destruction of equipment, or loss of effectiveness.

NOTE

Highlights an essential operating procedure, condition or statement.
SAFETY SUMMARY

If this equipment is used in a manner not specified in these instructions, protective systems may be impaired.

AUTHORIZED PERSONNEL

To avoid explosion, loss of life, personal injury and damage to this equipment and on-site property, all personnel authorized to install, operate and service the this equipment should be thoroughly familiar with and strictly follow the instructions in this manual. SAVE THESE INSTRUCTIONS.

DANGER
ELECTRICAL SHOCK HAZARD

Do not operate without doors and covers secure. Servicing requires access to live parts which can cause death or serious injury. Refer servicing to qualified personnel.

For safety and proper performance this instrument must be connected to a properly grounded three-wire source of power.

WARNING
POSSIBLE EXPLOSION HAZARD

This instrument is not designed for analysis of flammable gas samples. If flammable gas samples are introduced, internal leakage could create a flammable mixture which could result in an explosion.

WARNING
PARTS INTEGRITY

Tampering or unauthorized substitution of components may adversely affect safety of this product. Use only factory documented components for repair.
WARNING
HIGH PRESSURE GAS CYLINDERS
This instrument requires periodic calibration with a known standard gas. See Sections 2-9 on page 2-2, 3-11 on page 3-4 and 3-12 on page 3-4. See also General Precautions for Handling and Storing High Pressure Gas Cylinders, page P-on page 4.

WARNING
PARTS INTEGRITY
Tampering or unauthorized substitution of components may adversely affect safety of this product. Use only factory documented components for repair.

WARNING
TOPPLING HAZARD
This instrument’s internal pullout chassis is equipped with a safety stop latch located on the left side of the chassis. When extracting the chassis, verify that the safety latch is in its proper (counter-clockwise) orientation.

If access to the rear of the chassis is required, the safety stop may be overridden by lifting the latch; however, further extraction must be done very carefully to insure the chassis does not fall out of its enclosure.

If the instrument is located on top of a table or bench near the edge, and the chassis is extracted, it must be supported to prevent toppling.

Failure to observe these precautions could result in personal injury and/or damage to the product.
GENERAL PRECAUTIONS FOR HANDLING AND STORING HIGH PRESSURE GAS CYLINDERS

Edited from selected paragraphs of the Compressed Gas Association's "Handbook of Compressed Gases" published in 1981

Compressed Gas Association
1235 Jefferson Davis Highway
Arlington, Virginia 22202

Used by Permission

1. Never drop cylinders or permit them to strike each other violently.
2. Cylinders may be stored in the open, but in such cases, should be protected against extremes of weather and, to prevent rusting, from the dampness of the ground. Cylinders should be stored in the shade when located in areas where extreme temperatures are prevalent.
3. The valve protection cap should be left on each cylinder until it has been secured against a wall or bench, or placed in a cylinder stand, and is ready to be used.
4. Avoid dragging, rolling, or sliding cylinders, even for a short distance; they should be moved by using a suitable hand-truck.
5. Never tamper with safety devices in valves or cylinders.
6. Do not store full and empty cylinders together. Serious suckback can occur when an empty cylinder is attached to a pressurized system.
7. No part of cylinder should be subjected to a temperature higher than 125°F (52°C). A flame should never be permitted to come in contact with any part of a compressed gas cylinder.
8. Do not place cylinders where they may become part of an electric circuit. When electric arc welding, precautions must be taken to prevent striking an arc against the cylinder.
DOCUMENTATION

The following Model 868 instruction materials are available. Contact Customer Service Center or the local representative to order.

748003 Instruction Manual (this document)
CONDENSED STARTUP AND CALIBRATION PROCEDURE

Prior to shipment, this analyzer was subjected to extensive factory performance testing, during which all necessary optical and electrical adjustments were made. The following instructions are recommended for initial startup and subsequent standardization of the analyzer. In most cases, these simple instructions are sufficient to operate the analyzer. The detailed instructions given in Section 3 are required if the optical bench alignment has been disturbed, which could possible occur during shipment.

Leak Test Procedure

WARNING
POSSIBLE EXPLOSION HAZARD
This analyzer is not designed for analysis of flammable gas samples. If flammable gas samples are introduced, internal leakage could create a flammable mixture which could result in an explosion.

The following test is designed for sample pressure up to 10 psig (69 kPa).

1. Supply air or inert gas such as nitrogen at 10 psig (69 kPa) to analyzer via a flow indicator with a range of 0 to 250 cc/min. and set flow rate at 125 cc/min.

2. Use a suitable test liquid such as SNOOP (PN 837 801) to detect leaks. Cover all fittings, seals, or possible leak sources.

3. Check for bubbling or foaming which indicates leakage and repair as required. Any leakage must be corrected before introduction of sample and/or application of electrical power.

Power Verification

1. Verify power switch settings are correct for available power (115 VAC or 230 VAC).

2. Apply power. Verify that heater LED is on (decimal point of Mode display) and that chopper LED is blinking (decimal point of Range display).

3. Move RANGE switch to CH position and verify per Table P-1.

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<th>SWITCH POSITION</th>
<th>FUNCTION</th>
<th>READING</th>
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<tr>
<td>0</td>
<td>+5 VDC</td>
<td>4.75</td>
</tr>
<tr>
<td>1</td>
<td>-5 VDC</td>
<td>-4.50</td>
</tr>
<tr>
<td>2</td>
<td>+15 VDC</td>
<td>+14.25</td>
</tr>
<tr>
<td>3</td>
<td>-15 VDC</td>
<td>-14.25</td>
</tr>
<tr>
<td>4</td>
<td>+12 VDC</td>
<td>+11.4</td>
</tr>
<tr>
<td>5</td>
<td>REF Voltage</td>
<td>2.4</td>
</tr>
<tr>
<td>6</td>
<td>+ Source V¹</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>- Source V¹</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Source I¹</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Preamp Out¹</td>
<td></td>
</tr>
</tbody>
</table>

Table P-1. Range Switch Settings

Analyzer is now calibrated for Range 1. If the analyzer is to be used on auxiliary Range 2 and/or Range 3, perform the steps in Calibration of Range 2 and Calibration of Range 3 below.

¹ Determined by application. See Infrared Analyzer Calibration and Data Sheet, located in the rear of this manual.
Model 868

Calibration

1. Allow system to warm-up a minimum of one hour.

2. Connect zero gas to the sample cell inlet at the back of the analyzer. Flow the gas at a flow rate of 500 cc/min, as read on a flowmeter, through the analyzer for at least two minutes. Adjust the ZERO control on front panel so meter or recorder reads zero.

3. Connect the upscale gas to the sample cell inlet.
   a. Verify that RANGE switch is in Position 1 (least sensitive range).
   b. Flow the upscale gas appropriate for Range 1, at a flow rate of 500 cc/min., through the analyzer for at least two minutes.
   c. Adjust the SPAN control on the front panel so the display reads the desired output. Refer to the calibration curves in Section 8.

Calibration of Range 2

1. Place RANGE switch at Position 2.

2. Flow upscale gas appropriate to Range 2, at a flow rate of 500 cc/min., through the analyzer for at least two minutes.

3. Adjust switches S2, S3, and S4 for desired reading. (S4 is the least sensitive switch).

Calibration of Range 3

1. Place RANGE switch at Position 3.

2. Flow upscale gas appropriate to Range 3, at a flow rate of 500 cc/min., through the analyzer for at least two minutes.

3. Adjust switches S5, S6, and S7 for desired reading. (S7 is the least sensitive switch).

Time Constant Switch S9

Set switch S9 to the desired speed of response of the electronics (time constant).

The analyzer is now calibrated for all three ranges and is ready for sample analysis.
SECTION 1
DESCRIPTION AND SPECIFICATIONS

1-1 OVERVIEW

The Model 868 Non-Dispersive Infrared Analyzer (NDIR) continuously determines the concentration of a particular component of interest in a flowing mixture. The analysis is based on a differential measurement of the absorption of infrared energy. With the proper selection of detector, optics and cells, the instrument has a wide range of applications, subject only to the limitation that the analysis involve the determination of a single component, which must absorb infrared energy.

Within the analyzer, two equal energy infrared beams are directed through two parallel optical cells, a flow-through sample cell and a sealed reference cell. Solid-state electronic circuitry continuously measures the difference between the amount of infrared energy absorbed in the two cells. This difference is a measure of the concentration of the component of interest in the sample. Readout is on a front panel display with 0 to 199.9 digital display. In addition, a +5 VDC output for a potentiometric (voltage) recorder is provided as standard. Additional outputs (0 to 10 mV, 0 to 100 mV, 0 to 1 VDC) are available as options.

A calibration curve may be used to convert display or recorder readings into concentration values. The analyzer may utilize an optional linearizer circuit for linear readout of concentration values on the display and on a recorder.

The analyzer is equipped for remote selection of ranges.
1-2 SPECIFICATIONS

Repeatability.......................... 1% of fullscale
Noise .................................................. 1% of fullscale
Zero/Span Drift\(^1\) ...................... ±1% of fullscale per 24 hours
Response Time (Electronic) .... Variable, 90% of fullscale in 0.5 to 5 seconds, field selectable
Sensitivity ........................................ 500 p/10\(^6\) fullscale carbon monoxide 200 p/10\(^6\) fullscale carbon dioxide
Sample Cell Length ................. 0.04 inches (1mm) to 9.5 inches (24mm)
Materials in Contact with Sample
   Windows .................................. Sapphire, quartz, Irtran
   Cells ............................ Gold-plated glass or stainless steel
   Tubing .................................. FEP Teflon
   Fittings .................................. 316 stainless steel
   O-rings .............................. Viton-A
Sample Flow Rate ....................... Nominal 500 to 1000 cc/min.
Sample Pressure ....................... Maximum 10 psig (69 kPa)
Ambient Temperature Range .... 50 to 104°F (10 to 40°C)
Analog Output
   Standard .......................... 0 to 5 VDC
   Optional .......................... 0 to 10 mV, 0 to 100 mV, 0 to 1 VDC (selectable)
Linearization ........................... Optional microprocessor based
Power Requirements ................. 115/230 VAC ±10%; 50/60 Hz ±3%; 115 W
Enclosure .......................... General purpose for installation in weather protected area
Dimensions ........................... 8 11/16 inches (220 mm) H
   19 inches (483 mm) W
   16 inches (406 mm) D (with handles)
Weight ................................... 32 lbs (15 kg)
Shipping Weight ......................... Approximately 46 pounds (21 kg)

\(^1\) Performance specifications based on an ambient temperature variation of less than 20°F (11°C) per hour.
SECTION 2
INSTALLATION

2-1 UNPACKING
Carefully examine the shipping carton and contents for signs of damage. Immediately notify the shipping carrier if the carton or its contents are damaged. Retain the carton and packing material until the instrument is operational.

2-2 LOCATION
Preferably the analyzer should be mounted near the sample stream to minimize sample transport time. Of two or more alternative installation sites, select the one subject to the least vibration.

The analyzer must be installed in a weather-protected, non-hazardous location.

2-3 FACILITY PREPARATION

a. Power Requirements
115 or 230 VAC ±10% single phase
47 to 53 or 57 to 63 Hz
Less than 115 watts

b. Gas Connections
Sample and reference IN and OUT lines are ¼ inch tube.

2-4 OUTLINE AND MOUNTING DIMENSIONS
The Model 868 has three mounting variations:
- Panel mount
- Rack mount (Standard RETMA 19 inch)
- Table mount

Refer to installation drawing 620474 in the rear of this manual.

General Notes for Installation
- General purpose enclosure
- 3-prong, six foot power cord supplied with analyzer

2-5 POWER CONNECTIONS

WARNING
ELECTRICAL SHOCK HAZARD
For safety and proper performance, this analyzer must be connected to a properly grounded 3-wire source of electrical supply.

CAUTION
Before applying power, perform the Voltage Select procedure below.

a. Voltage Select Board
The voltage select board is located in the power receptacle on the rear panel. Check that line voltage and circuit board to insure that desired voltage is face up on trailing edge of board as it is inserted (Figure 2-1 on page 2-2).
b. **Heater Voltage Select**

The heater voltage select switch is located inside the chassis in the lower right corner of the power supply board. Slide switch to position of desired voltage (Figure 2-2 below).

![Heater Voltage Select](image)

**Figure 2-2. Heater Voltage Select**

- **Fuse Select Panel**

The fuse select panel is located on the rear panel. Select the appropriate amperage:

- 230 VAC = 0.5 amp
- 115 VAC = 1.0 amp

---

### 2-6 RECORDER CONNECTION

The recorder connections are made to the rear panel at TB2. See drawings 620474 and 620126.

- Maximum distance recorder to analyzer – 1000 feet (305 meters)
- Recorder cable – minimum 20 gauge shielded (customer-supplied)

---

### 2-7 REMOTE RANGE

The remote range connections are made to the rear panel. See drawings 620474 and 620126.

- Maximum distance remote to analyzer – 1000 feet (305 meters)
- Remote cable – minimum 20 gauge (customer supplied). Refer to Section 5-3f on page 5-6.

---

### 2-8 SAMPLE INLET/OUTPUT CONNECTIONS

Sample inlet and outlet connections are located on the rear panel. This instrument is intended for atmospheric pressure operation only. Vent must go to atmosphere. Connections are ¼ inch tubing.

---

### 2-9 CALIBRATION GAS REQUIREMENTS

Analyzer calibration consists of setting a zero point and one or more upscale points.

All applications require a zero standard gas to set the zero point on the display or recorder chart. If the factory Calibration and Data Sheet (in the rear of this manual) specifies the background gas, use it as the zero gas. If background gas is not specified, use dry nitrogen for the zero gas.
2-10 SAMPLE HANDLING SYSTEM

Many different sample handling systems are available, either completely assembled or as loose components. The type used depends on the requirements of the particular application and the preferences of the individual user. Typically, the sample handling system incorporates such components as pumps, valves to permit selection of sample, zero standard, or upscale standard gas; needle valve in sample-inlet line for flow adjustment; flowmeter for flow measurement and/or indication of flow stoppage; and filter(s) to remove particulate matter.

2-11 LEAK TEST

DANGER POSSIBLE EXPLOSION HAZARD

This instrument is not designed for analysis of flammable gas samples. If flammable gas samples are introduced, internal leakage may result creating a flammable mixture which could result in an explosion.

The following procedure is designed for sample pressure up to 10 psig (69 kPa).

1. Supply air or inert gas such as nitrogen at 10 psig (69 kPa) to analyzer via a flow indicator with a range of 0 to 250 cc/min.

2. Set flow rate at 125 cc/min.

3. Use a suitable test liquid such as SNOOP (PN 837801) to detect leaks. Cover all fittings, seals and all sources of possible leaks.

4. Check for bubbling or foaming which indicates leaks.

5. Correct any leakage for introduction of sample and/or application of electrical power.

2-12 SAMPLE FLOW RATE

For best results, the sample flow rate must be in the range of 1 to 2 SCFH (500 to 1000 cc/min.). A subnormal flow rate will result in undesirable time lag.

Assume that two cell columns are required to flush any cell. Table 2-1, on page 2-4, indicates approximate flushing time at atmospheric sampling pressure, i.e., the outlet of the cell venting to a atmosphere for various cell lengths.

Flushing time is inversely proportional to flow rate.

The primary effect of flow rate, other than flushing time, is cell pressure. Due to the restriction of the exit tubing, increasing flow rate increases sample pressure in the cell. For a 9-inch (232 mm) cell venting to atmosphere, the cell pressure rises from 0 psig (0 kPa) at no flow, essentially linearity, by 1 mm Hg per CFH flow up to at least 20 CFH (10 L/min.).

At 7.5 to 8.0 CFH (3.8 to 4 L/min.), therefore, the pressure is increased by about 1%, and the output signal is thereby increased by about the same 1% over static conditions. In all cases, the effect of pressure on readout is eliminated if the same flow rate is used for the measured sample as well as for the zero gas and span gas.

It should be noted that at higher flow rates, because of increase in sample cell pressure, the non-linearity of the calibration curve increases. Therefore, if higher flow rates are required, the calibration curve should be redrawn at these same flow rates.

At 2 CFH (1 L/min.) gaseous sample temperatures are equilibrated to instrument temperature regardless of stream temperature. At extremely high flow rates, this may not be true, but no such effect has been noted up to 18 CFH (9 L/min.).
### Table 2-1. Purging Time at Atmospheric Sample Pressure

<table>
<thead>
<tr>
<th>Cell Length (mm)</th>
<th>Cell Volume (CC) (Without inlet tube)</th>
<th>Total Volume (CC) (Cell with inlet tube)</th>
<th>Time For Two Volumes @ 2 Scfh (1L/min) @ 750 mm Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>.157</td>
<td>1.14</td>
<td>2 sec</td>
</tr>
<tr>
<td>8</td>
<td>.315</td>
<td>2.28</td>
<td>2 sec</td>
</tr>
<tr>
<td>16</td>
<td>.630</td>
<td>4.56</td>
<td>2 sec</td>
</tr>
<tr>
<td>32</td>
<td>1.25</td>
<td>9.12</td>
<td>2 sec</td>
</tr>
<tr>
<td>64</td>
<td>2.52</td>
<td>18.24</td>
<td>3 sec</td>
</tr>
<tr>
<td>128</td>
<td>5.03</td>
<td>36.48</td>
<td>3 sec</td>
</tr>
<tr>
<td>232</td>
<td>9.13</td>
<td>66.12</td>
<td>6 sec</td>
</tr>
</tbody>
</table>

**2-13 DIFFERENTIAL ANALYSIS WITH FLOW THROUGH REFERENCE CELL**

In some applications the analyzer is used to measure the difference between the concentration of the component of interest in two sample streams. If so, the reference side of the analyzer, as well as the sample side, utilizes a flow-through cell. The sample cell receives the sample stream, which contains the higher concentration of the component of interest. The reference cell receives the stream containing the lower concentrations of this component.
SECTION 3
DETAILED STARTUP

3-1 STARTUP
During final factory test all controls and adjustments were set so that all field adjustments can be accomplished using the front panel display and the controls located behind the door in the front panel.

3-2 CURRENT SOURCE ADJUSTMENT
Refer to Figure 3-1 below.

1. RANGE switch in CH position.
2. CHECK switch in Position 8. This displays the current through the sources. The reading must be multiplied by 100 to obtain the current in milliamps. Clockwise adjustment of R5 will increase the value. Counterclockwise will decrease the value. Adjust for desired current as indicated on data sheet for the application.

3. Move CHECK switch to Positions 6 and 7. Position 7 shows the negative output driver signal in volts. Position 6 shows the positive output driver signal. These should be within 50 mV of each other.

Figure 3-1. Source Current Adjustment

3-3 DISPLAY READOUTS USING CHECK SWITCH

<table>
<thead>
<tr>
<th>CHECK SWITCH POSITION</th>
<th>FUNCTION</th>
<th>READING</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>+5 VDC</td>
<td>4.75 to 5.25 VDC</td>
</tr>
<tr>
<td>1</td>
<td>-5 VDC</td>
<td>-4.5 to -5.1 VDC</td>
</tr>
<tr>
<td>2</td>
<td>+15 VDC</td>
<td>+14.25 to 15.75 VDC</td>
</tr>
<tr>
<td>3</td>
<td>-15 VDC</td>
<td>-14.25 to -15.75 VDC</td>
</tr>
<tr>
<td>4</td>
<td>+12 VDC</td>
<td>+11.4 to 12.6 VDC</td>
</tr>
<tr>
<td>5</td>
<td>REF Voltage</td>
<td>2.4 to 2.6 VDC</td>
</tr>
<tr>
<td>6</td>
<td>+ Source V</td>
<td>See note</td>
</tr>
<tr>
<td>7</td>
<td>- Source V</td>
<td>See note</td>
</tr>
<tr>
<td>8</td>
<td>Source I</td>
<td>See note</td>
</tr>
<tr>
<td>9</td>
<td>Preamp Out</td>
<td>voltage will vary</td>
</tr>
</tbody>
</table>

Note: Determined by application. See Factory Data Sheet in the rear of this manual.

Table 3-1. Range Switch Readings
3-4 RANGE SWITCH POSITION (O.T.) OSCILLATOR TUNE

Refer to Figure 3-2 below.

1. This procedure is not necessary on a routine basis. Record initial number and check for any change exceeding ±5%. To check the tuning, turn the RANGE Switch to O.T.

2. Adjust coil (located on right side of detector housing) clockwise until a maximum reading is obtained on the display.

3. Adjust coil counterclockwise until unit reads 75% and 80% of the maximum value. This positions the system for correct operation.

3-5 RANGE SWITCH

REMOTE Position

Allows the range selection unit to be controlled from a remote source.

Positions 1, 2, and 3

Allow manual selection of range.

3-6 TIME CONSTANT SELECTION

Set by switch (S9) located behind the front panel door. This switch selects speed of response of the electronics. The base line will be noisier on 1/2-second response than on 2.5-second response. Refer to Figure 3-2 below.

Note

At least one switch must be depressed, but DO NOT energize more than one switch at a time. It is recommended that the system operate in the slowest mode that is required by the system.

Figure 3-2. Front Panel Controls
3-7 PREAMP GAIN ADJUSTMENT

1. Place the RANGE switch to the CH position and the CHECK switch in position 9.

2. Flow calibration gas for the least sensitive range through the SAMPLE CELL for a minimum of 2 minutes.

   An Example:
   
   Range 1 - 5000 p/10^6 CO
   Range 2 - 2000 p/10^6 CO
   Range 3 - 500 p/10^6 CO

   In this case the system would use a 5000 p/106 CO calibration gas.

3. If the calibration gas is not equal to fullscale, find the percent fullscale of the calibration gas by looking at the application curve at the back of the manual.

4. Multiply this value with preamplifier gain potentiometer R3, located on the filter rectifier board (located in the detector housing, Figure 6-4 on page 6-5), for the value obtained in Step 4. THIS VALUE SHOULD NEVER BE HIGHER THAN 7.5.

   NOTE
   For applications with very low concentrations, for example, Range 3 = 400 ppm CO, the fullscale value may be considerably less than 7.5 volts.

3-8 SOURCE BALANCE SHUTTER ADJUSTMENT

1. Place the RANGE switch to the CH position and the CHECK switch in Position 9.

2. Flow zero gas (nitrogen) through the SAMPLE CELL for at least 2 minutes.

3. Loosen jam nut slightly on the shutter adjust screw (located on the rear of the motor-source assembly).

4. Using a 3/16 Allen wrench, rotate the shutter adjust screw until a minimum reading (at the display) is obtained (typical 0.2 to 1.2). Note the reading. Add 0.4 to this reading and note. This will be the new value for Step 5.

5. Rotate the shutter adjust screw clockwise (viewed from screw head) until display indicates the new value obtained in Step 4.

6. Hold the wrench securely to prevent screw rotation and retighten the jam nut.

3-9 ZERO ADJUST

Zero adjustment is located behind the right side of the front panel. This potentiometer is used to obtain a zero reading when a zero gas is being run through the instrument.

3-10 SPAN ADJUSTMENT

This potentiometer sets the system for the least sensitive reading.

Example - Measuring 0 to 5000 p/10^6 CO, 0 to 2000 ppm CO, and 0 to 500 p/10^6 CO

Range 1 (Span Pot) - 5000 p/10^6 CO
Range 2 (Switches) - 2000 p/10^6 CO
Range 3 (Switches) - 500 p/10^6 CO

In this case the system would use a 5000 p/10^6 CO calibration gas and would be spanned using the front panel span pot. Ranges 2 and 3 would be calibrated to additional calibration gases. Once the ranges are set, then the span pot affects Range 2 and 3 proportionally.
3-11 CALIBRATION WITHOUT LINEARIZER

1. With instrument at operating temperature introduce zero gas (normally nitrogen) (Minimum flow of 500 cc/min) with RANGE switch (warmed up for 1 hour) in Position 1. Adjust zero control for reading of 00.0 ± .5.

2. Introduce calibration gas for least sensitive reading (minimum flow of 500 cc/min). Allow adequate purge time for steady results.

3. Adjust span control for 100.0 ± .5 reading.

4. Flow Cal Gas #2 (RANGE switch in Position 2). Adjust range 2 switches for percent of fullscale reading (XXX.X) corresponding to concentration of span gas.

5. Flow Cal Gas #3 (RANGE switch to Position 3). Adjust range 3 switches for percent of fullscale reading (XXX.X) corresponding to concentration of span gas.

This concludes the calibration procedure.

3-12 CALIBRATION WITH LINEARIZER

Any instrument ordered with a linearizer has been calibrated and needs no further adjustment. To verify its operation, introduce zero and span gases, then an intermediate span gas. The points will be in a linear position on a plot of the response versus gas concentrations.

For a detailed description of the linearizer, see Section 7-3 on page 7-5.

For switch setup see Configuration Selection Table 7-4 on page 7-8 and Infrared Analyzer Calibration and Data Sheet, included with the engineering drawings at the end of the manual.
SECTION 4
OPERATION

4-1 ROUTINE OPERATION

First perform Condensed Startup and Standardization Procedure (page P-6). Then set RANGE switch for desired operating range: 1, 2, or 3. Pass sample gas through instrument. It will now automatically and continuously analyze the sample stream.

With standard (non-linearized) potentiometric output, use calibration curve on Infrared Analyzer Calibration and Data Sheet (placed at rear of this manual) to convert meter or recorder readings into concentrations of the measured component. However, if the analyzer is equipped with a linearizer circuit board adjusted for the particular operating range, the calibration curve is not required.

As a check on instrument performance, it is recommended that the operator keep a daily log of the SPAN control setting.

4-2 RECOMMENDED CALIBRATION FREQUENCY

Maximum permissible interval between calibrations depends on the analytical accuracy required and cannot, therefore, be specified. It is recommended that initially the instrument be calibrated once every 8 hours and that this practice be continued until experience indicates that some other interval is more appropriate.

A change in cell pressure of 1 inch of mercury (3.38 kPa) will result in a readout error of approximately 3% of fullscale. Therefore, if barometric pressure changes significantly, it is advisable to recheck the calibration against an upscale standard gas.

4-3 SHUTDOWN

Normally, instrument power is left on at all times except during a prolonged shutdown. Following shutdown, repeat Condensed Startup and Standardization Procedure (page P-6).
SECTION 5
THEORY

5-1 OVERVIEW
Section 5-2 below explains the functioning of the detection system. Section 5-3 on page 5-2 describes the electronic circuitry. Section 5-4 on page 5-9 describes board functions.

5-2 DETECTION SYSTEM
As shown in Figure 5-1 below, the analyzer produces infrared radiation from two separate energy sources. Once produced, this radiation is beamed separately through a chopper, which interrupts it at 10 Hz. Depending on the application, the radiation may then pass through optical filters to reduce background interference from other infrared-absorbing components.

Each infrared beam passes through a cell, one containing a continuous flowing sample and the other cell sealed or with a continuous flowing reference gas.

During operation, a portion of the infrared radiation is absorbed by the component of interest in the sample, with the quantity of infrared radiation absorbed being proportional to the component concentration. The detector is a "gas microphone" based on the Luft principle. It converts the difference in energy between sample and reference cells to a capacitance change. This capacitance change, equivalent to component concentration, is amplified and indicated on the display and, if desired, used to drive a recorder.

Figure 5-1. Functional Diagram of Detection System
5-3 ELECTRONIC CIRCUITRY

The block diagram of Figure 5-2 on page 5-3 traces the signal through the electronic circuitry and depicts the various waveforms involved. Details of circuit boards and other individual circuits are shown in separate schematic diagrams included at the end of this manual.

a. Oscillator Circuit Board and Associated Elements of Amplitude-Modulation Circuit

In the Oscillator Circuit (drawing 619803) the 10 MHz carrier wave is generated by a crystal-controlled radio-frequency oscillator using crystal Y1 and transistors Q1 and Q2.

The modulation circuit is driven by the detector, the sensing element of the analyzer. Considered electronically, the detector is a two-plate variable capacitor. The modulator is coupled inductively, through one winding of inductance T1, to the oscillator. Amplitude of the 10 MHz carrier thus varies with the 10 Hz modulation signal.

b. Functioning of Modulation System in TUNE Mode

Preparatory to oscillator tuning, the RANGE switch is placed in TUNE position to connect the electronic circuitry in a configuration shown in the functional diagram of Figure 5-3 on page 5-5. In this mode the display indicates the rms value of the halfwave-rectified carrier. The tank circuit is now adjusted in the following two-step sequence:

1. Tuning: Initially, the OSC TUNE adjustment is set somewhat counterclockwise from its correct setting. Then, it is rotated clockwise to move the slug into the core, thus increasing inductance and decreasing resonant frequency. The adjustment is set for maximum obtainable meter reading. At this setting, tank-circuit resonant frequency is the same as oscillator frequency (i.e., nominal 10 MHz). See Resonance Curve Number 1, Figure 5-3 on page 5-5.

2. Detuning: By counterclockwise rotation of the OSC TUNE adjustment, the slug is partially withdrawn from the core, thus decreasing inductance and increasing resonant frequency. The adjustment is set so meter reading decreases to between 75% and 80% of the maximum obtainable value noted in Step 1, above. See Resonance Curve Number 2, Figure 5-3 on page 5-5.

3. This curve has the same shape as that obtained in Step 1, immediately preceding, but is displaced to the right.
Figure 5-2. Signal Circuitry
c. Functioning of Modulation System in Operating Mode

After tuning is completed, the RANGE switch should be moved to Position 1 to place the zero and calibration circuitry in operation. In this mode, the meter indicates the amplitude of the 10 Hz detector output signal. Overall sensitivity of the analyzer system may now be checked by removing the sample beam to simulate total absorption of sample-beam energy and thus provide the maximum obtainable 10 Hz detector-output signal. During that portion of the chopping cycle, while the chopper is unblocking the sample and reference beams, the diaphragm distends away from the metal button, thus decreasing detector capacitance and shifting the tank-circuit resonance curve to the right. At the moment the diaphragm reaches maximum distention, the curve reaches the position of Curve 3, Figure 5-3 on page 5-5.

Assume that the analyzer is now placed in normal operation by removing the blockage from the sample beam and passing sample gas through the sample cell. The diaphragm now pulses cyclically, causing the resonance curve to move continuously back and forth within the limits defined by Curves 2 and 3 of Figure 5-3 on page 5-5. Carrier amplitude decreases as the curve moves to the right and increases as it moves to the left. Thus, the response characteristics of the system depend on the location of Curve 2. Position of this curve depends on the degree of tank-circuit detuning used. Advantages of operating on the portion of the curve obtained by detuning to 75% to 80% of the maximum obtainable carrier amplitude are that maximum slope yields highest sensitivity and that minimum curvature provides best linearity.

d. Radio-Frequency Demodulator

The amplitude-modulated 10 MHz carrier from the detector/oscillator circuit is applied to the radiofrequency demodulator. This circuit is a voltage-doubler type rectifier utilizing diodes CR1, CR2, CR3, CR4, and capacitor C7. The circuit gives approximately double the output voltage of a conventional halfwave rectifier. This result is obtained by charging a capacitor during the normally wasted half-cycle, and then discharging it in series with the output voltage during the next half-cycle.

e. Filter/Rectifier Board and Associated Elements

Within the Filter/Rectifier Board, drawing 620249, the signal passes in turn through the following stages:

1. Buffer Amplifier: The signal from the detector/oscillator combination is applied to a buffer amplifier U1 A. The output signal from the buffer amplifier is applied to the preamp GAIN Control R3. This potentiometer changes the gain of the overall system by adjustable attenuation of the signal applied to the 10 Hz bandpass filter, item 2.

2. 10 Hz Bandpass Filter: This active filter, utilizing operational amplifier U2A, U2B, U4 discriminates against all frequencies other than the 10 Hz chopping frequency. The resultant clean 10 Hz signal, with undesired frequencies filtered out, is observable by connecting an oscilloscope to TP12. Filter pass adjustment potentiometer R12 is adjusted for maximum amplitude of the 10 Hz signal.

3. Fullwave Rectifier Circuit: This circuit provides fullwave rectification of the 10 Hz signal. Filter Balance potentiometer R17 is used to equalize peak heights of adjacent halfwave pulses.
A. Functional Diagram - Circuitry in Tune Mode

B. Tank Circuit Resonance Curves

Note: Decrease in inductance and/or capacitance in tank circuit shifts resonance curve to right, decreasing carrier amplitude.

Figure 5-3. Modulation System
f. **Remote Range Control**

Refer to drawing 619839, Sheet 1. This system utilizes an external 24 VDC power source that is referenced to the user's ground.

The + 24 VDC is supplied to relay K1 and is switched to the common terminal of relays K2, K3, and K4 during manual operation and to the Auto terminal during remote operation.

When in the manual position, the range is selected by means of the RANGE select switch on the front panel. The 24 VDC is switched via the relay contact to the range line for range identification. In addition the selected range is displayed at the range display.

When in RMT (Remote) position, U1 is energized and the 24 VDC are fed to the auto line for extended use. The user is now able to switch the 24 VDC back to the desired range line. The selected range is displayed at the range display.

When in the auto mode, K1 is energized, and the 24 VDC supply is switched for external use. The user switches the 24 VDC back on the line corresponding to the range desired. This causes the associated opto to function, which selects the display and the set of range switches.

Remote Range Select with Indication of Range Position (Figure 5-4 below)

![Figure 5-4. Remote Range Select Circuit](image)

 Requires the following:

- 24 VDC supply with 100 mA capability
- 3-position single pole switch
- Four (4) 2300 ohm 1/2 watt resistors
- Four (4) LED's (10 mA) of your choice.
- One (1) diode (1N914 or equivalent)

When the system is in RMT (front panel control), the + 24 VDC is fed back on the 24 VDC return may be grounded at the switch location.
NOTE

The REMOTE switch is in operation when the RANGE switch is in remote position.

Automatic Range Changing at Remote Location (Figure 5-5 below)

Requires the following:

- 24 VDC, 100 mA
- Computer

Local Operation

This allows the computer to read the range lines and determine which range is selected. During local operation + 24 VDC is fed over the relay contacts (K2, K3, K4) back to the computer.

Remote Operation

This allows the computer to generate commands for the different ranges. In remote operation + 24 VDC is fed to the auto line. The computer can now switch the + 24 VDC to the optical couplers that activate the different ranges.

g. Source Driver

Refer to drawings 620126 and 619839, Sheet 1)

This driver is capable of providing a constant current of 500 to 900 mA AC at 960 Hz. This amplitude is adjustable, using R5 located on the front panel board.

The output of R5 is fed to AR1 so that a gain of 1.58 is attained. This occurs in AR1, and there is a negative voltage output on pin 1 and positive on pin 7. These outputs are fed through analog switches U4 that is switched at a 960 Hz rate that comes from the crystal controlled oscillator. This allows an AC square wave to be sent to AR1, located on the heat sink.

This voltage on pin 4 of the power amplifier causes current to flow through the sources, which also flows through the 3 ohm resistor (R7). The current causes a voltage across the 3 ohm resistor, which is fed back to the negative input of the power amplifier. This closes the loop and causes the constant current.

The voltage is monitored across R7 (3 ohm) by U1, which rectifies the positive side of the signal and converts it to dc voltage. This is scaled so that the readout on the display indicates the current.

Figure 5-5. Automatic Range Select Circuit
h. Analog Signal Path

Refer to Figure 5-2 on page 5-3. The pre-amp signal is fed into a low pass filter to remove frequencies above 10 Hz. This is fed to the time constant selection circuit which determines the electronic response of the system. This allows a selection of (0.5, 1, 2.5, or 5 sec) for 90% of fullscale response. The zero amplifier attenuates this signal by 5 and also allows the zero signal to be subtracted from the system. (This is done with the front panel zero pot, which is located behind the front door.) AR3 is a unity gain buffer amplifier, which feeds the range changing DAC U8.

The AR5 gain is determined by the bit pattern that is applied to U8. In Range 1, switches S2 through S7 are disabled, and the DAC has 1’s on all of its inputs. This is the condition of unity minimum gain.

The DAC is a 12-bit device and has the following transfer function.

$$E_{out} = \frac{E_{in} \cdot 4096}{[4096 - (D0 + D1 + \cdots + D11)]}$$

Where Do to D11 are data bits from the switches, D0 is the least significant bit (LSB), and D11 is the most significant bit (MSB).

Two examples:

Switch Settings (Hexadecimal) 800

<table>
<thead>
<tr>
<th>Binary Value</th>
<th>1000 0000 0000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain</td>
<td>$$\frac{4096}{4096 - 2048} = \frac{4096}{2048} = 2$$</td>
</tr>
</tbody>
</table>

Switch Settings (Hexadecimal) DAC

<table>
<thead>
<tr>
<th>Binary Value</th>
<th>1 1 0 1 1 0 1 0 0 0 1 0</th>
</tr>
</thead>
</table>

The span potentiometer sets the analog gain for the system. When the RANGE switch is set to Range 1, the gain of the DAC is 1. When the RANGE switch is set to Range 2 or Range 3, the Hex multiplier switches are enabled, and, for either range, the gain of the DAC may be set to a value between 1 and 10.

Set HEX switches to 000 for gain = 1; set to E67 for gain = 10.
5-4 CHOPPER DRIVER

Refer to drawing 619839, Sheet 1. U1 is a divider that reduces the frequency of the oscillator to the values shown. The stepping motor requires 240 pulses/sec to rotate at 5 rev/sec. This is derived from the divider circuit.

U2, U3, and U5 are designed to drop the pulse rate to 120 pulses/sec to allow the chopper to restart.

U7 is a stepper driver circuit that sequences the pulses to the appropriate windings.

The pickup is an optically coupled LED/transistor which is interrupted by the chopper blade. This information is displayed on the front panel.

a. Recorder Output

Refer to drawings 619839, Sheet 1 and 620126.

AR5 is in the feedback loop of the ADC U8, which does all of the gain changing. AR4 is a non-inverting amplifier of gain 5 that provides a buffered recorder output (+ 5 VDC) to the rear terminal located on the back of the power supply board. An optional recorder output board (P/N 620391) mounts at TB1 (Recorder Output Terminal; refer to Item G, drawing 620474) and provides a selectable output of 10 mV, 100 mV, or 1 volt.

c. Power Supply

Refer to drawing 620126.

This board contains the following:

1. Power Supplies
   + 15 VDC - Analog
   -15 VDC - Analog
   + 12 VDC - Chopper Drive
   +5 VDC - Logic
   Source Power
   500 ma/9 VAC tap for linearizer power

2. Heater Switch (S1)

3. Remote Range Connectors

4. Recorder Output

5. Connector to Linearizer (J5)

6. Source Current Control

The function of each is described in the individual section.

K1 to switch ON. The sensor is a resistor with a positive temperature coefficient (1.925 ohms/°C). The resistance is 500 ohms at 0 °C.

Resistors R1 5 through R20, Q1, Q2 and C5 provide the circuit for the time proportioning action; C5 charges through R1 6 until the voltage on C5 reaches 9.0 V. Q1 then discharges C5, and the charging process repeats itself. The emitter of Q2 follows the voltage on C5, which is essentially a triangle. This is injected into the bridge, which causes the setpoint to bump.

b. Temperature Control

Refer to drawings 619839, Sheet 1 and 620126.

This is a proportional temperature controller, which works on a variable time method.

Resistors R23, 24, 25, 26, 27 and the sensor form a bridge which feeds AR2. AR2 operates in an ON/OFF mode to drive transistor Q3, which, in turn, causes
SECTION 6
SERVICE AND TROUBLESHOOTING

4. Loosen cells by inserting small screw driver or Allen wrench into holes in the rod adjusting nut (Figure 6-1 on page 6-2) and turning counterclockwise to loosen. Loosen so that cells can be removed.

5. After cleaning cells, examine 0-rings at the source and detector ends. If damaged, replace with new 0-rings. If not, replace with same.

6-1 CELL REMOVAL AND REPLACEMENT

1. Slide chassis out.

2. Remove sample lines from source end.

3. Loosen source hold-down bolt so that the source assembly is loose. It is not necessary to remove bolt. Refer to Figure 6-2 on page 6-3.

4. Loosen cells by inserting small screw driver or Allen wrench into holes in the rod adjusting nut (Figure 6-1 on page 6-2) and turning counterclockwise to loosen. Loosen so that cells can be removed.

5. After cleaning cells, examine 0-rings at the source and detector ends. If damaged, replace with new 0-rings. If not, replace with same.

6. Remove any contaminants from the windows with a lint-free cloth soaked in acetone. Do not use alcohol or other solvents. Allow to air dry.

7. To replace the cells, fit them into position and tighten the tie rod, adjusting nut with the fingers until the cells are held in place. Insure that the cells are seated against the "0" rings. Use a small screw driver or pin to tighten the tie rod adjusting nut. Tighten until the cells will not rotate. DO NOT OVER TIGHTEN.

8. Tighten the source removal bolt.

Note
Motor source and optical assemblies in instruments with serial numbers pre 2000000, utilizing a short path cell (Figure 6-5 on page 6-6), were sealed with a liquid silicone rubber. Motor source and optical assemblies with serial numbers 2000000 and above use a silicone gasket. If assemblies sealed with liquid silicone rubber are disassembled and reassembled without scraping off the old material before resealing with RTV or a gasket, leakage may occur, especially on CO2 applications. A symptom of leakage is a drifting baseline. Note the gasket part numbers in Table 7-1 on page 7-2, Table 7-2 on page 7-3 and Table 7-3 on page 7-4.

CAUTION
FLAMMABLE CHEMICAL
Acetone is highly flammable and moderately toxic. Use only in well ventilated, flame-free, non-smoking area. Prolonged inhalation of vapors can cause headache, dizziness, and irritation of the eyes, nose, and throat and should be avoided. Contact with skin can cause milk irritation and should be avoided. Use rubber gloves and eye protection.
Figure 6-1. Configuration Assembly – Part 1
Figure 6-2. Configuration Assembly – Part 2
Figure 6-3. Configuration Assembly – Part 3
Figure 6-4. Configuration Assembly – Part 4
Figure 6-5. Motor/Source Assembly
6-2 CELL CLEANING

Rinse the cell with acetone. If this does not remove all foreign matter, use a soft bristle brush. After all matter has been removed, rinse with acetone and allow to air dry. Do not use towels. The glass cells are resistant to scratching but care should be taken not to damage the surface.

6-3 CELL DESICCANT

The reference cell may use a reference or zero gas. If so, no desiccant is required.

If the ends are capped off, a desiccant holder should be used on both ends to keep moisture from entering the reference cell.

6-4 SOURCE HOUSING REMOVAL

Follow the same procedure used to remove the cells. However, remove the source removal bolt and the tie rod, adjusting nut until the source assembly is loose.

a. Source Removal

Refer to Figure 6-5 on page 6-6. Matched sources must be changed as a pair. Do not change singly. Observe how the parts are disassembled so that the reverse procedure can be used for assembly.

1. Remove front cover.
2. Remove chopper blade. Insure that it does not get bent.
3. Remove cover with window. The sources are now accessible.
4. Remove screws that retain the sources. Observe how the sources are mounted.
5. The pins holding the sources in place are spring-loaded. Use a small driver, as shown, to remove. To reinsert, push connector over post.

b. Chopper Motor Replacement

Remove two screws from rear of motor and replace.

6-5 DETECTOR REMOVAL

1. Remove top cover from detector housing.
2. Remove filter-rectifier board. Do not lose standoffs.
3. Remove housing.
4. Detector is mounted to the base plate. Remove entire assembly.
5. Remove end cap assembly.
6. Remove oscillator board.
7. Remove detector.
8. Clean all heat sink compounds from base plate.
9. Replace detector and repeat process in reverse.
6-6 TROUBLESHOOTING PROCEDURES

a. Chopper Drive
If the front panel indicator does not blink, refer to Section 5-4 on page 5-9.

b. Temperature Controller
Reference Section 5-4b on page 5-9. There are three sections that can cause a malfunction.

Heater - Check with an ohmmeter for continuity. The heater resistance is approximately 1130 ohms.

Temperature Sensor - This is an RTD and should have approximately 550 ohms at 25°C. Check with ohmmeter for continuity.

Over Temperature Fuse - This is a thermal fuse that opens above 72°C. Check with an ohmmeter.

If the above are functional, refer to circuit schematic.

c. Source Drive
Reference Section 5-3g on page 5-7.

1. Check for resistance of both sources. Total resistance should be 24 ± 3 ohms.

2. Monitor the front panel display.
   RANGE switch to CH position
   CHECK switch to position 8
   Reading should be between 7.50 to 9.00. If not, refer to Section 5-3g on page 5-7.

d. Voltage Checks
Use CHECK switch as detailed in the Condensed Startup and Standardization Procedure on page P-6.
SECTION 7
REPLACEMENT PARTS

WARNING
PARTS INTEGRITY
Tampering or unauthorized substitution of components may adversely affect safety of this instrument. Use on factory-documented components for repair.

The following parts are recommended for routine maintenance and troubleshooting of your instrument. If the troubleshooting procedures do not resolve the problem, contact your local service office. For configuration/application parts list, refer to Table 7-1 through Table 7-3. Figure 6-1 through Figure 6-5 show locations of components and assemblies.

7-1 CIRCUIT BOARD REPLACEMENT POLICY

In most situations involving a malfunction of a circuit board, it is more practical to replace the board than to attempt isolation and replacement of the individual component. The cost of test and replacement will exceed the cost of a rebuilt assembly. As standard policy, rebuilt boards are available on an exchange basis.

Because of the exchange policy covering circuit boards the following list does not include individual electronic components. If circumstances necessitate replacement of an individual component, which can be identified by inspection or from the schematic diagrams, obtain the replacement component from a local source of supply.

7-2 RECOMMENDED REPLACEMENT PARTS

620244  Board, Range Switch
619838  Board, Display
620125  Board, Power Supply
619802  Board, Oscillator
622137  Board, Linearizer
620248  Board, Filter Rectifier
620273  Board, Sensor
620390  Board, Recorder Range Output
898658  LED DS-4-5-6
898657  LED DS-3
879043  LED DS-2
898724  Amplifier Power
620290  Transformer
620298  Heater, 50 W
620341  Sensor, Temperature
620346  Sources, Matched Pair
898733  Fuse, Thermal
871860  Crystal Oscillator
610471  Motor Source Assembly
620345  Motor Chopper
000 148  Fuse, 1 Amp (115 VAC operation)
092114  Fuse, 0.5 Amp (220 VAC operation)
<table>
<thead>
<tr>
<th>CONFIGURATION</th>
<th>10</th>
<th>12</th>
<th>13</th>
<th>18</th>
<th>22</th>
<th>23</th>
<th>38</th>
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<td>856317</td>
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<td>---</td>
<td>---</td>
<td>635889</td>
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Table 7-1. Parts List - Configuration/Application 10, 12, 13, 18, 22, 23, 38, 42, 43
### Table 7-2. Parts List – Configuration/Application 26

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<th>Part Description</th>
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<td>2. Sample Cell</td>
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<tr>
<td>4. Reference</td>
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</tr>
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<td>8. O-Ring</td>
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<td>9. Cell, Plug</td>
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</tr>
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<td>10. Source Cap Assembly</td>
<td>620306</td>
</tr>
<tr>
<td>11. Mica Window</td>
<td>635889</td>
</tr>
<tr>
<td>12. Retaining Ring</td>
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<td>13. Gasket</td>
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<td>CO₂</td>
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<td>C-31</td>
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### CONFIGURATION

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Table 7-3. Parts List - Configuration/Application 11, 21, 31, 36, 41, 44, 54, 56
7-3 LINEARIZATION KIT
The linearizer kit (P/N 623192) consists of the following: Linearizer Board Assembly (P/N 622137), Harness (P/N 622153), P. C. Board Spacer (P/N 900848), and EPROM Kit (P/N 622188). A functional diagram of the linearizer board is shown in Figure 7-1 on page 7-9.

a. Installation

**WARNING**
Disconnect power to instrument before installation of board.

The linearizer board is installed on the bottom plate of the Infrared Analyzer, using four standoffs. Refer to Figure 7-2 on page 7-10.

b. Electrical Connections
Refer to Figure 7-2 on page 7-10.

1. Select the end of the harness on which the 12-pin connector P1 is installed. Insert this connector into Connector J1 on the linearizer board.

2. Select the end of the harness on which the 6-pin connector P5 is installed. Insert this connector into connector J5 on the power supply board of the Infrared Analyzer.

3. Select the remaining end of the harness, on which a 2-pin connector P6 is installed. Route this portion of the harness under the optical bench of the analyzer and insert the 2-pin connector into connector A on the front panel board of the Infrared Analyzer.

4. The second step involves placing a jumper across E1-E2, or across E2-E3, depending on the maximum nonlinearity of the configuration. The correct position for each configuration is shown in Table 7-4 on page 7-8.

5. Set the poles of Switch SW1 as required.

6. Place the jumper across E1-E2 or E2-E3 as required.

**NOTE**
Switch SW2 (on Linearizer Board) allows the user to select either the nonlinearized signal (NORM) or the linearized signal (LIN) to be returned to the analyzer for output. Normally, the user will select the LIN position.

2. Set switch SW2 as desired.

3. The remaining setup of the linearizer board is accomplished in two steps. The first step consists of placing each of the eight poles of switch SW1 (on the linearizer board) in the proper position, as shown in Table 7-4 Configuration Selection Table and on the Infrared Analyzer Calibration and Data Sheet placed at the end of the manual. For example, if the analyzer is configured to measure carbon monoxide with a 4 mm cell, and maximum full-scale is 15%, the positions for the poles of switch SW1 are as follows:

<table>
<thead>
<tr>
<th>POLE</th>
<th>POSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Off</td>
</tr>
<tr>
<td>7</td>
<td>On</td>
</tr>
<tr>
<td>6</td>
<td>On</td>
</tr>
<tr>
<td>5</td>
<td>On</td>
</tr>
<tr>
<td>4</td>
<td>On</td>
</tr>
<tr>
<td>3</td>
<td>On</td>
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<td>2</td>
<td>On</td>
</tr>
<tr>
<td>1</td>
<td>On</td>
</tr>
</tbody>
</table>

4. The second step involves placing a jumper across E1-E2, or across E2-E3, depending on the maximum nonlinearity of the configuration. The correct position for each configuration is shown in Table 7-4 on page 7-8.

5. Set the poles of Switch SW1 as required.

6. Place the jumper across E1-E2 or E2-E3 as required.
d. Troubleshooting and Repair
Because specialized test equipment is required for the digital portion of the circuit, troubleshooting and field repair is not recommended. However, the board has built-in capability to perform simple tests of proper operation.

NOTE
The reference voltage is critical and must be accurate for proper operation.

1. Using a precision DVM, monitor J1, pin 9, with respect to J1, pin 11. The voltage (Ref) must be 500 ± 1 millivolts. If necessary, adjust R1 0.

2. Place all poles of switch SW1 in the ON position. Place switch SW2 in the NORM position, and use the SPAN and ZERO controls of the Infrared Analyzer to apply known voltages at E IN (measure at R14). The voltage E OUT (measure at TP2) should be the same within +5 millivolts. If the voltage at E IN is between 0 and -1 volt, the voltage at DAC OUT is measured at Test Point TP3) should be positive and 10 times the voltage at E IN, within ± 5 millivolts. If the voltage at E IN is positive or more negative than -1 volt, then the voltage at DAC OUT should be 0.

3. Place Switch SW2 in the LIN position. As E IN is varied from 0 to -1 volt, the voltage at E OUT should vary proportionately from 0 to -0.8 volt. If E IN is increased just beyond -1 volt, the voltage at E OUT should abruptly jump to the same value as that at E IN, within a few millivolts. If the voltage at E IN is positive or more negative than -1 volt, the voltage at E OUT should be the same, within a few millivolts.

e. Board Functions (Linearizer)
The function of the linearizer is to accept a 0 to -1 volt intermediate nonlinear output from the Infrared Analyzer and to return a linearized 0 to -1 volt signal. When the signal from the analyzer is outside the range of 0 to -1 volt, i.e., off-scale, the linearizer returns the output, uncorrected.

The linearizer board performs its function in three steps. First, it senses the intermediate output of the analyzer. Second, using a fourth-order polynomial fit, it computes a correction value. Third, it subtracts the correction value from the intermediate output of the analyzer, producing a linear output. Refer to drawing 622190.

The linearizer consists of five principal blocks: a microcomputer, a DIP selector switch, a digital-to-analog converter (DAC), an analog-to-digital converter (ADC), and analog output amplifiers. The normally negative signal from the analyzer (E IN) is applied to the ADC for acquisition by the microcomputer. The same signal is also applied to the input of summing amplifier AR1. The microcomputer scans the DIP selector switch (SW1) to determine which set of coefficients (factory stored in microcomputer memory) to use in the polynomial computation. When the microcomputer has computed the magnitude of the correction, it outputs the corresponding voltage by means of the DAC. If switch SW2 is closed, the positive correction voltage is applied to the input of summing amplifier AR1. The output of amplifier AR1 is the desired linearized signal, except it is of positive polarity. Unity Gain Inverter AR2 produces the desired negative output. Because of the scaling used at the input of amplifier AR1, the linearizer can correct up to a 20% or 25% nonlinearity, depending on the placement of the resistor-selection jumper. The DAC output, 10 volts maximum, is applied via a 499k ohm resistor (20% maximum nonlinearity) or a 402k ohm resistor (25% maximum nonlinearity). While the signal from the analyzer, -1 volt fullscale, is applied via a 10K ohm resistor.
f. **Linearized Analyzer**

To understand how the Model 868 Analyzer functions with a linearizer board in place, refer to Figure 7-4 on page 7-10, a high-level block-diagram of the analyzer, and to Figure 7-5 on page 7-11, which depicts the behavior of the instrument at various places within the block diagram.

The output of the detector is applied to a signal-conditioning circuit. In turn, that circuit produces a 0 volt output for zero gas and a -1 volt output for a span gas with a concentration equal to the fullscale rating of the instrument. For intermediate concentrations, the output of the circuit is a nonlinear function of the gas concentration (Figure 7-5A on page 7-11).

The output of the signal-conditioning circuit is applied to the linearizer board. In turn, the linearizer board also produces a 0 volt output for zero gas and a -1 volt output for a span gas with a concentration equal to the fullscale rating of the instrument. However, as described in Section 8.5, the linearizer operates on its nonlinear input in such a way as to produce an output which is a linear function of the gas concentration (Figure 7-5B on page 7-11).

The output of the linearizer board is applied to a range select/amplify circuit. If Range 1 is selected, the range select/amplify circuit scales the output of the linearizer board so that the display and recorder are at 0 for zero gas and at fullscale for a span gas with a concentration equal to the fullscale rating of the instrument (Figure 7-5C on page 7-11). However, if Range 2 or 3 is selected, the range select/amplify circuit can also amplify the output of the linearizer board, so that a span gas with an intermediate concentration can drive the display and recorder to fullscale (Figure 7-5D on page 7-11). Amplifications up to times ten can be selected. For example, if an analyzer is rated 6000 ppm CO fullscale, then that is always the fullscale associated with Range 1. However, Range 2 and Range 3, independently, can have nearly any fullscale sensitivity desired between 600 ppm and 6000 ppm.

Placing the range amplification after the linearizer means that only one linearization "curve" (actually a set of coefficients microcomputer memory) per instrument is required. If the nonlinear signal were amplified and then linearized, an individual linearization "curve" would be required for each of the large number of intermediate fullscales which can be provided by Ranges 2 and 3. Figure 7-6 on page 7-12 illustrates the relationship between Range 1 and Range 2. Figure 7-7 on page 7-12 illustrates the relationship between Range 1 and Range 3. Note that, for Ranges 2 and 3 fullscale linearized response does not equal fullscale nonlinear response.
### Table 7-4. Linearized Configuration Selection

<table>
<thead>
<tr>
<th>COEFFICIENT / CONFIGURATION OR WORKSHEET</th>
<th>COMPONENT</th>
<th>MAX. FULLSCALE</th>
<th>CELL LENGTH</th>
<th>JUMPER</th>
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<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>PROM REV</th>
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<td>38/38 CO2</td>
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<td>41/41 N-Hexane</td>
<td>5000 ppm</td>
<td>128 mm</td>
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<td>42/42 N-Hexane</td>
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<td>54/54 NO</td>
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Notes: Jumper E1-E3 connects 402K Resistor (non-standard).
Prom revision indicates first appearance of configuration on EPROM 622188.
Figure 7-1. Functional Diagram of Linearizer Board

Figure 7-2. Installation of Linearizer Board
Figure 7-3. Linearizer Setup Switches

Figure 7-4. Block Diagram, Model 868 Electronics
Figure 7-5. Behavior of Instrument within Block Diagram
Figure 7-6. Example Showing Relationship Between Range 2 and Range 1 Responses When Sensitivity of Range 2 is 100/60 Times Sensitivity of Range 1

Figure 7-7. Example Showing Relationship Between Range 2 and Range 1 Responses When Sensitivity of Range 3 is 100/37 Times Sensitivity of Range 1
SECTION 8
RETURN OF MATERIAL

8-1 RETURN OF MATERIAL

If factory repair of defective equipment is required, proceed as follows:

1. Secure a return authorization from a Rosemount Analytical Inc. Sales Office or Representative before returning the equipment. Equipment must be returned with complete identification in accordance with Rosemount instructions or it will not be accepted.

   Rosemount CSC (Customer Service Center) will provide the shipping address for your instrument.

In no event will Rosemount be responsible for equipment returned without proper authorization and identification.

2. Carefully pack the defective unit in a sturdy box with sufficient shock absorbing material to ensure no additional damage occurs during shipping.

3. In a cover letter, describe completely:
   - The symptoms that determined the equipment is faulty.
   - The environment in which the equipment was operating (housing, weather, vibration, dust, etc.).
   - Site from where the equipment was removed.
   - Whether warranty or non-warranty service is expected.
   - Complete shipping instructions for the return of the equipment.

4. Enclose a cover letter and purchase order and ship the defective equipment according to instructions provided in the Rosemount Return Authorization, prepaid, to the address provided by Rosemount CSC.

   If warranty service is expected, the defective unit will be carefully inspected and tested at the factory. If the failure was due to the conditions listed in the standard Rosemount warranty, the defective unit will be repaired or replaced at Rosemount’s option, and an operating unit will be returned to the customer in accordance with the shipping instructions furnished in the cover letter.

   For equipment no longer under warranty, the equipment will be repaired at the factory and returned as directed by the purchase order and shipping instructions.

8-2 CUSTOMER SERVICE

For order administration, replacement Parts, application assistance, on-site or factory repair, service or maintenance contract information, contact:

   Rosemount Analytical Inc.
   Process Analytic Division
   Customer Service Center
   1-800-433-6076

8-3 TRAINING

A comprehensive Factory Training Program of operator and service classes is available. For a copy of the Current Operator and Service Training Schedule contact:

   Rosemount Analytical Inc.
   Process Analytic Division
   Customer Service Center
   1-800-433-6076
WARRANTY

Goods and part(s) (excluding consumables) manufactured by Seller are warranted to be free from defects in workmanship and material under normal use and service for a period of twelve (12) months from the date of shipment by Seller. Consumables, glass electrodes, membranes, liquid junctions, electrolyte, o-rings, etc., are warranted to be free from defects in workmanship and material under normal use and service for a period of ninety (90) days from date of shipment by Seller. Goods, part(s) and consumables proven by Seller to be defective in workmanship and/or material shall be replaced or repaired, free of charge, F.O.B. Seller's factory provided that the goods, part(s) or consumables are returned to Seller's designated factory, transportation charges prepaid, within the twelve (12) month period of warranty in the case of goods and part(s), and in the case of consumables, within the ninety (90) day period of warranty. This warranty shall be in effect for replacement or repaired goods, part(s) and the remaining portion of the ninety (90) day warranty in the case of consumables. A defect in goods, part(s) and consumables of the commercial unit shall not operate to condemn such commercial unit when such goods, part(s) and consumables are capable of being renewed, repaired or replaced.

The Seller shall not be liable to the Buyer, or to any other person, for the loss or damage directly or indirectly, arising from the use of the equipment or goods, from breach of any warranty, or from any other cause. All other warranties, expressed or implied are hereby excluded.

IN CONSIDERATION OF THE HEREIN STATED PURCHASE PRICE OF THE GOODS, SELLER GRANTS ONLY THE ABOVE STATED EXPRESS WARRANTY. NO OTHER WARRANTIES ARE GRANTED INCLUDING, BUT NOT LIMITED TO, EXPRESS AND IMPLIED WARRANTIES OR MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Limitations of Remedy. SELLER SHALL NOT BE LIABLE FOR DAMAGES CAUSED BY DELAY IN PERFORMANCE. THE SOLE AND EXCLUSIVE REMEDY FOR BREACH OF WARRANTY SHALL BE LIMITED TO REPAIR OR REPLACEMENT UNDER THE STANDARD WARRANTY CLAUSE. IN NO CASE, REGARDLESS OF THE FORM OF THE CAUSE OF ACTION, SHALL SELLER'S LIABILITY EXCEED THE PRICE TO BUYER OF THE SPECIFIC GOODS MANUFACTURED BY SELLER GIVING RISE TO THE CAUSE OF ACTION. BUYER AGREES THAT IN NO EVENT SHALL SELLER'S LIABILITY EXTEND TO INCLUDE INCIDENTAL OR CONSEQUENTIAL DAMAGES. CONSEQUENTIAL DAMAGES SHALL INCLUDE, BUT ARE NOT LIMITED TO, LOSS OF ANTICIPATED PROFITS, LOSS OF USE, LOSS OF REVENUE, COST OF CAPITAL AND DAMAGE OR LOSS OF OTHER PROPERTY OR EQUIPMENT. IN NO EVENT SHALL SELLER BE OBLIGATED TO INDEMNIFY BUYER IN ANY MANNER NOR SHALL SELLER BE LIABLE FOR PROPERTY DAMAGE AND/OR THIRD PARTY CLAIMS COVERED BY UMBRELLA INSURANCE AND/OR INDEMNITY COVERAGE PROVIDED TO BUYER, ITS ASSIGNS, AND EACH SUCCESSOR INTEREST TO THE GOODS PROVIDED HEREUNDER.

Force Majeure. Seller shall not be liable for failure to perform due to labor strikes or acts beyond Seller's direct control.
2. CAPACITOR VALUES ARE IN MICROFARADS, 500V.
1. RESISTOR VALUES ARE IN OHMS, ±5%, 1/4W.

NOTES: UNLESS OTHERWISE SPECIFIED
2. Capacitor values are in microfarads.
1. Resistor values are in ohms, ±1%, 1/8W.

Notes: Unless otherwise specified.
1. RESISTOR VALUES ARE IN OHMS ±.1%, 1/4W.

NOTES: UNLESS OTHERWISE SPECIFIED.

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TOLERANCES
- X = ±.250  ANGULAR = ±2°  30°  ±.003  MACH SURF.
- Threads, Class 2A or 2B
- Remove Burr & Sharp edges 0.005 Max.
- Mach. Felt Radius 0.002 Max.
- Mach. Surf. Flat within 0.002 in./in.
- Other Surf. Flat within 0.005 in./in.
- T.I.R. within 1/2 of dia. Tools, 0.0005 Max.
- Do not scale drawing.

Rosemount Analytical Inc.

DIAGRAM, SCHEMATIC - RECORDER RANGE OUTPUT

A SIZE
- CODE IDENT NO.
- DWG. NO.
- 020 - 620391

SCALE -- INIT USE 868 SHEET 1 OF 1
RECOMMENDED PANEL CUTOUT
SCALE 1/4

4. CLEARANCE HOLE 1/2" DIA.
3. INSTRUMENT NOT WEATHERPROOF.
2. APPROXIMATE WEIGHT 32 LB/14.5 KG.
1. STANDARD 19" RACK MOUNT.

NOTES:

G. TB2, CUSTOMER WIRING FOR RECORDER.
F. TB1, CUSTOMER WIRING FOR REMOTE CONTROL.
E. LINE VOLTAGE SELECTOR, 100/120 V OR 220/240 V AC, 50/60 HZ
(Power cord supplied by Rosemount Analytical, Springs Parallel Blade North American style for 115 V)
D. SAMPLE INLET, .25 INCH TUBE.
C. SAMPLE OUTLET, .25 INCH TUBE.
B. REFERENCE INLET, .25 INCH TUBE.
A. REFERENCE OUTLET, .25 INCH TUBE.

Model 868