Rosemount Analytical

MODEL 755
OXYGEN ANALYZER

INSTRUCTION MANUAL

748183-J

NOTICE

Manual Part Number 748183-J
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Rosemount Analytical Inc.
4125 East La Palma Avenue
Anaheim, California 92807-1802

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PREFACE

INTENDED USE STATEMENT

The Model 755 is intended for use as an industrial process measurement device only. It is not intended for use in medical, diagnostic, or life support applications, and no independent agency certifications or approvals are to be implied as covering such application.

SAFETY SUMMARY

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 Model 755 Oxygen Analyzer should be thoroughly familiar with and strictly follow the instructions in this manual. **Save these instructions.**

DANGER is used to indicate the presence of a hazard which **will** cause **severe** personal injury, death, or substantial property damage if the warning is ignored

WARNING is used to indicate the presence of a hazard which **can** cause **severe** personal injury, death, or substantial property damage if the warning is ignored.

CAUTION is used to indicate the presence of a hazard which **will** or **can** cause **minor** personal injury or property damage if the warning is ignored.

NOTE is used to indicate installation, operation, or maintenance information which is important but not hazard-related.

WARNING: 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

The general purpose Model 755 Oxygen Analyzer, catalog number 191102, is for operation in non-hazardous locations. It is of a type capable of analysis of sample gases which may be flammable. If used for analysis of such gases, the instrument must be protected by a continuous dilution purge system in accordance with Standard ANSI/NFPA-496-1086 (Chapter 8) or IEC Publication 79-2-1983 (Section Three).

The explosion-proof Model 755 Oxygen Analyzer, catalog number 632440, is for operation in hazardous locations. The enclosure must be properly secured with all flange bolts in place and tightened, lens cover fully engaged, all factory installed flame arrestor assemblies are properly installed in sample inlet and outlet and any unused openings plugged with approved threaded plugs properly secured in place. Installation must be made in accordance with applicable parts of the NEC, especially Articles 501-4(a) and 501-5(a)(1).

If explosive gases are introduced into this analyzer, the sample containment system must be carefully leak-checked upon installation and before initial start-up, during routine maintenance and any time the integrity of the sample containment system is broken, to ensure the system is in leak-proof condition. Leak-check instructions are provided in Section 2.7.

Internal leakage of sample resulting from failure to observe these precautions could result in an explosion causing death, personal injury, or property damage.

CAUTION: 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 analyzer requires periodic calibration with known zero and standard gases. See General Precautions for Handling and Storing High Pressure Cylinders, in the rear of this manual.

SPECIFICATIONS - GENERAL[1]

CATALOG NUMBER

191102 General Purpose for operation in non-hazardous locations
632440 Explosion-Proof for operation in hazardous locations

STANDARD RANGE OPTIONS (% OXYGEN FULLSCALE)[2]

0 to 1, 2.5, 5, and 10% fullscale
0 to 5, 10, 25, and 50% fullscale
0 to 10, 25, 50, and 100% fullscale
0 to 1, 2.5, 5 and 25% fullscale
0 to 1, 5, 10, and 25% fullscale
50 to 100, 60 to 100, 80 to 100, and 90 to 100% fullscale

RESPONSE TIME (90% OF FULLSCALE)

Factory set for 20 seconds; adjustable from 5 to 25 seconds.

REPRODUCIBILITY

±0.01% Oxygen or ±1% of fullscale, whichever is greater

AMBIENT TEMPERATURE LIMITS

Maximum: 49°C (120°F)
Minimum: -7°C (20°F)

ZERO AND SPAN DRIFT[3]

±1% of fullscale per 24 hours, provided that ambient temperature does not change by more than 11.1°C (20°F).

±2.5% of fullscale per 24 hours with ambient temperature change over entire range.

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[1] Performance specifications based on recorder output.

[2] For applications requiring suppressed ranges other than those provided, we recommend the Model 755A Oxygen Analyzer, Catalog Number 617720. This instrument includes automatic correction for barometric pressure variations and provides maximum accuracy for suppressed ranges. This particularly important at high level suppressed ranges such as 99 to 100% where a barometric pressure change from standard 29.90 inches Hg (101 kPa) to 31.5 inches Hg (106 kPa) would result in an actual oxygen change in the order of 5%. The Model 755A provides automatic barometric pressure correction and optimum accuracy for such suppressed ranges. The Model 755A also provides direct readout from 0.00% to 100.00% oxygen on a digital display. Optimum resolution of the oxygen reading is provided.

[3] Zero and span drift specifications based on following conditions: Operating pressure constant; ambient temperature change from initial calibration temperature, less than 11.1 Celsius degrees (20 Fahrenheit degrees); deviation from set flow held to within ±10% or ±20 cc/min, whichever is smaller.

SPECIFICATIONS - SAMPLE

DRYNESS

Sample dewpoint below 43°C (110°F), sample free of entrained liquids.

TEMPERATURE LIMITS

Maximum: 66°C (150°F)
Minimum: 10°C (50°F)

OPERATING PRESSURE

Maximum: 69 kPa (10 psig).

Minimum: 88.1 kPa absolute (660 mm Hg absolute pressure)

FLOW RATE [4]

Maximum: 500 cc/min
Minimum: 50 cc/min
Recommended: 250 ±20 cc/min

MATERIALS IN CONTACT WITH SAMPLE GAS

316 stainless steel, glass, titanium, Paliney No. 7, epoxy resin, Viton-A, platinum, nickel.

SPECIFICATIONS - ELECTRICAL

SUPPLY VOLTAGE AND FREQUENCY (SELECTABLE WHEN ORDERED)

Standard: 115 VAC ±10 VAC, 50/60 Hz
Optional: 230 VAC ±10 VAC, 50/60 Hz

POWER CONSUMPTION

Maximum: 300 watts

OUTPUTS

Standard: Field selectable voltage output of 0 to 10mV, 0 to 100mV, 0 to 1V, or 0 to 5VDC

Optional: Isolated current output of 0 to 20mA or 4 to 20mA (with Current Output Board)

ALARM OPTION

High-Low Alarm

Contact Ratings:
5 amperes, 240V AC, resistive   3 amperes, 120 VAC inductive
1 amperes, 24V DC, resistive   5 amperes, 30 VDC resistive
5 amperes, 120V AC, resistive   3 amperes, 30 VDC inductive

SETPOINT

Adjustable from 1% to 100% of fullscale

DEADBAND

Adjustable from 1% to 20% of fullscale (Factory set at 10% of fullscale)

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[4] Deviation from set flow would be held to within ±10% or ±20 cc/min, whichever is smaller. If so, zero and span drift will be within specifications, provided that operating temperature remains constant.

SPECIFICATIONS - PHYSICAL GENERAL PURPOSE ENCLOSURE

MOUNTING

Standard: Panel mount
Optional: Surface or stanchion mount accessory available

ENCLOSURE CLASSIFICATION

Meets requirements for NEMA 3R
Air Purge Option[5]: NFPA 496 (1989) Type Z purge

REFER TO INSTALLATION DRAWING 632349 IN THE REAR OF THIS MANUAL.

SPECIFICATIONS - PHYSICAL EXPLOSION-PROOF ENCLOSURE

MOUNTING

Surface or wall

ENCLOSURE CLASSIFICATION

Class I, Groups B, C, and D, Division 1 hazardous locations (ANSI/NFPA 70)

REFER TO INSTALLATION DRAWING 643127 IN THE REAR OF THIS MANUAL.

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[5] When installed with user supplied components, meets requirements for Class I, Division 2 locations per National Electrical Code (ANSI/NFPA 70) for analyzers sampling nonflammable gases. Analyzers sampling flammable gases must be protected by a continuous dilution purge system in accordance with Standard ANSI/NFPA 496-1986, Chapter 8. Consult factory for recommendations.

CUSTOMER SERVICE, TECHNICAL ASSISTANCE AND FIELD SERVICE

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

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

RETURNING PARTS TO THE FACTORY

Before returning parts, contact the Customer Service Center and request a Returned Materials Authorization (RMA) number. Please have the following information when you call: *Model Number, Serial Number, and Purchase Order Number or Sales Order Number.*

Prior authorization by the factory must be obtained before returned materials will be accepted. Unauthorized returns will be returned to the sender, freight collect.

When returning any product or component that has been exposed to a toxic, corrosive or other hazardous material or used in such a hazardous environment, the user must attach an appropriate Material Safety Data Sheet (M.S.D.S.) or a written certification that the material has been decontaminated, disinfected and/or detoxified.

Return to:

Rosemount Analytical Inc.
4125 East La Palma Avenue
Anaheim, California 92807-1802

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 the Technical Services Department at:

Rosemount Analytical Inc.
Phone: 1-714-986-7600
FAX: 1-714-577-8006

DOCUMENTATION

The following Model 755 Oxygen Analyzer instruction materials are available. Contact Customer Service or the local representative to order.

748183 Instruction Manual (this document)

COMPLIANCES

MODEL 755 OXYGEN ANALYZER - GENERAL PURPOSE ENCLOSURE

The Model 755 Oxygen Analyzer (general purpose enclosure), catalog number 191102, has been designed to meet the applicable requirements of the U.S. Occupational Safety and Health Act (OSHA) of 1970 if installed in accordance with the requirements of the National Electrical Code (NEC) of the United States in non-hazardous areas and operated and maintained in the recommended manner.

MODEL 755 OXYGEN ANALYZER - EXPLOSION-PROOF ENCLOSURE

The Model 755 Oxygen Analyzer (explosion-proof enclosure), catalog number 632440, is approved by Factory Mutual (FM) for installation in Class I, Groups B, C, and D, Division 1, hazardous locations as defined in the National Electrical Code (NEC) of the United States (ANSI/NFPA 70).

FM
APPROVED

NOTES

1

INTRODUCTION

The Model 755 Oxygen Analyzer provides continuous read-out of the oxygen content of a flowing gas sample. The determination is based on measurement of the magnetic susceptibility of the sample gas. Oxygen is strongly paramagnetic, other common gases are weakly diamagnetic, with few exceptions.

The instrument provides direct read-out of oxygen concentration on a front-panel meter. In addition a field-selectable voltage output is provided as standard. An isolated current output of 4 to 20 mA or 0 to 20 mA is obtainable through plug-in of the optional circuit board. Current and voltage outputs may be utilized simultaneously, if desired.

The basic electronic circuitry is incorporated into two master boards designated the Control Board and the Case Board, see Figure 1-2. The Control Board has receptacles that accept optional plug-in circuit boards thus permitting inclusion of such features as current output and alarms, and facilitating conversion from one range option to another.

The analyzer is available in a general purpose enclosure or an explosion proof enclosure. See Figures 1-1.

1.1 RANGE OPTIONS

The Model 755 is supplied, as ordered, with four switch-selectable ranges: an overall range and three sub-ranges, each covering a portion of the overall range. The standard range options are of two general types: zero-based (Section 1.1.1) and zero-suppressed (Section 1.1.2). In addition, special range options incorporating combinations of zero-based and zero-suppressed ranges are available on factory special order, refer to Section 1.1.3. All range options utilize a front-panel meter with left-hand zero. See Figure 1-1 and Table 1-1.

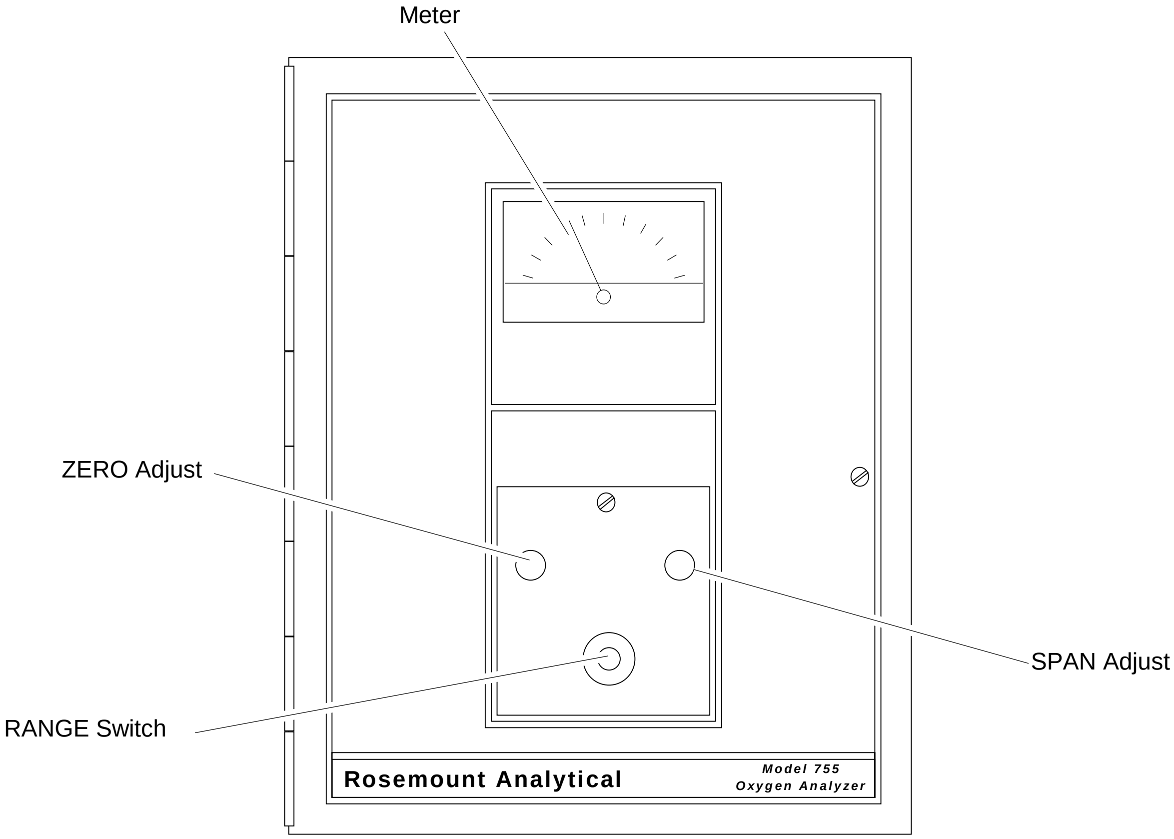
1.1.1 STANDARD ZERO-BASED RANGE OPTIONS

In a zero-based range option, the lower range-limit for all four ranges is 0% oxygen. There are five standard zero-based range options:

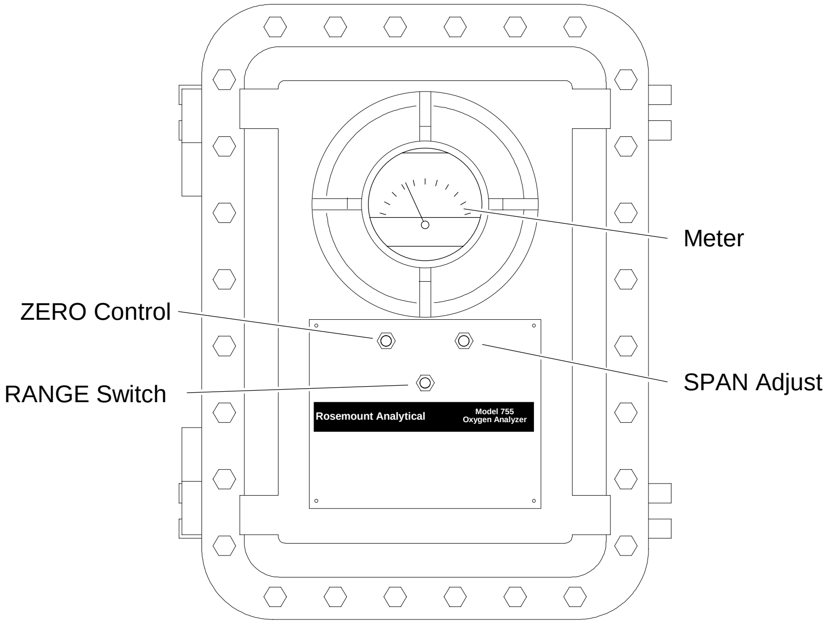
- Range Option
- Sub-Range A
- Sub-Range B
- Sub-Range C
- Overall Range

Refer to Table 1-2.

A. GENERAL PURPOSE ENCLOSURE



B. EXPLOSION-PROOF ENCLOSURE



Controls have slotted shafts for screwdriver adjustment from outside the enclosure.

FIGURE 1-1. MODEL 755 - FRONT VIEW

CONTROL	FUNCTION
METER	Indicates oxygen content of sample, provided the analyzer has been calibrated by appropriate adjustment of % RANGE switch, ZERO control, and SPAN control. Meter face is calibrated with scales covering the operating ranges provided.
%RANGE SWITCH	Select percentage oxygen range for meter and recorder
ZERO ADJUST	Used to establish downscale calibration point on meter scale or recorder chart. With suitable downscale standard gas flowing through the analyzer, the ZERO Control is adjusted for appropriate reading on meter or recorder.
SPAN ADJUST	Used to establish downscale calibration point on meter scale or recorder chart. With suitable downscale standard gas flowing through the analyzer, the ZERO Control is adjusted for appropriate reading on meter or recorder.

TABLE 1-1. FRONT PANEL CONTROLS

RANGE OPTION	SUB-RANGE A	SUB-RANGE B	SUB-RANGE C	OVERALL RANGE
01	0 to 1%	0 to 2.5%	0 to 5%	0 to 10%
02	0 to 5%	0 to 10%	0 to 25%	0 to 50%
03	0 to 10%	0 to 25%	0 to 50%	0 to 100%
04	0 to 1%	0 to 2.5%	0 to 5%	0 to 25%
06	90 to 100%	80 to 100%	60 to 100%	50 to 100%

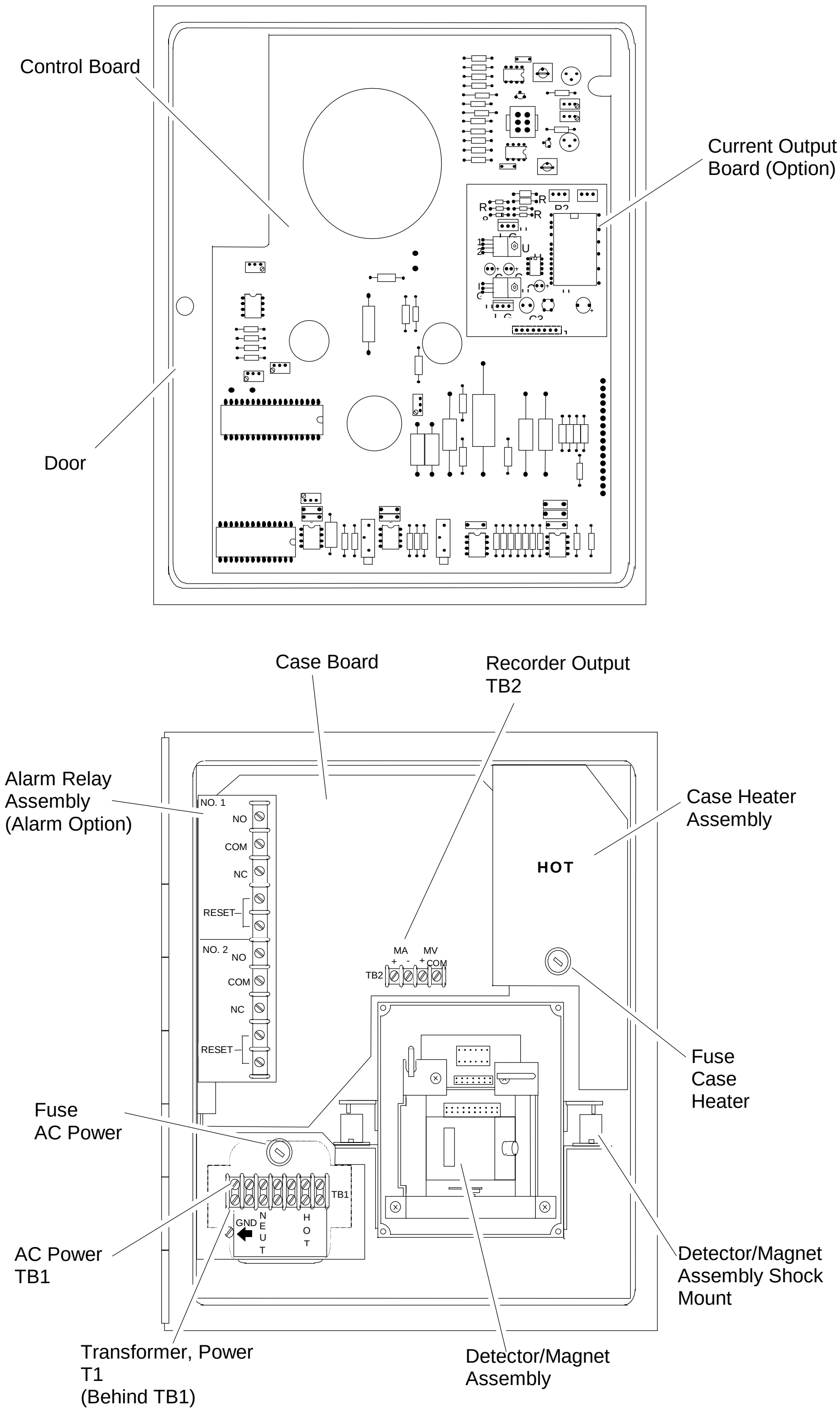
TABLE 1-2. RANGE OPTIONS

1.1.2 STANDARD ZERO-SUPPRESSED RANGE OPTIONS

With any zero-suppressed range the 0% oxygen point lies off-scale below the lower range-limit. In a zero-suppressed range option the four ranges have the same upper range-limit, but different lower range-limits. There is a standard zero-suppressed range option, as shown in Table 1-2.

1.1.3 SPECIAL RANGE OPTIONS

On factory special order, the analyzer may be provided with a special range option incorporating any desired combination of zero-based and zero-suppressed ranges, arranged in ascending order according to span.



General Purpose enclosure shown. Components mounted in same locations in Explosion-Proof enclosure.

FIGURE 1-2. MODEL 755 - LOCATION OF MAJOR COMPONENTS

1.2 ISOLATED CURRENT OUTPUT OPTIONS

An isolated current output is obtainable by installation of the optional Current Output Board, either during factory assembly or subsequently in the field. The maximum load resistance for this board is 850 ohms.

1.3 ALARM OPTION

If equipped with the alarm option:

1. On the Control Board there are two comparator amplifiers, one each for the ALARM l and ALARM 2 functions. Each amplifier has associated set-point and dead-band adjustments, set-point is adjustable from l% to l00% of full-scale. The dead-band is adjustable from l% to 20% of full-scale.
2. Alarm relay assembly, containing two single-pole double-throw relays, one for each of the alarm contacts. These relays may be used to drive external, customer-supplied alarm and/or control devices.

1.4 CASE MOUNTING OPTIONS

General Purpose Enclosure, see drawing 632349.
Explosion Proof Enclosure, see drawing 643127.

1.5 ELECTRICAL OPTIONS

The analyzer is supplied, as ordered, for operation on either 120 VAC, 50/60 Hz, or 240 VAC, 50/60 Hz.

NOTES

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 materials until the instrument is operational.

2.2 LOCATION

2.2.1 LOCATION AND MOUNTING

Shock and mechanical motion can reduce instrument accuracy; therefore, mount the instrument in an area that is as vibration free as possible

GENERAL PURPOSE ENCLOSURE

The analyzer is designed to meet NEMA 3R enclosure requirements and may be mounted outdoors. Permissible ambient temperature range is 20°F to 120°F (-7°C to 49°C).

The analyzer is designed for either surface or stanchion (optional kit) mounting. Avoid mounting outside in direct sunlight, or inside in a closed building, where ambient temperature may exceed the allowable maximum.

EXPLOSION-PROOF ENCLOSURE

The analyzer can be either surface or wall mounted and meets (ANSI/NFPA 70) Class 1, Groups B, C, and D, Division 1 Hazardous Locations.

2.3 VOLTAGE REQUIREMENTS

WARNING: 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.

Note

Refer to Installation Drawing 632349 or 643127 at the rear of this manual for recommended cable conduit openings.

CAUTION: ENCLOSURE INTEGRITY

With reference to Installation Drawing 632349 or 643127, any unused cable conduit openings must be securely sealed by permanent closures in order to provide enclosure integrity in compliance with personnel safety and environmental protection requirements. The plastic closures provided are for shipping protection only.

Note

For NEMA 3R service, all conduit must be connected through approved fittings.

The analyzer is supplied, as ordered, for operation on 120 VAC or 240 VAC, 50/60 Hz. Make sure that the power source conforms to the requirements of the individual instrument, as noted on the name-rating plate.

2.4 ELECTRICAL CONNECTIONS

2.4.1 LINE POWER CONNECTIONS

Electrical power is supplied to the analyzer via a customer-supplied three-conductor cable, type SJT, minimum wire size 18 AWG. Route power cable through conduit and into appropriate opening in the instrument case. Refer to Installation Drawing (632349 or 643127). Connect power leads to HOT, NEUT, and GND terminals on TB1, Figure 2-1. Connect analyzer to power source via an external fuse or breaker, in accordance with local codes.

Note

Do not draw power for associated equipment from the analyzer power cable.

2.4.2 RECORDER OUTPUT SELECTION AND CABLE CONNECTIONS

If a recorder, controller, or other output device is used, connect it to the analyzer via a 22 or 24 AWG two-conductor shielded cable. Route the cable through conduit to the analyzer, and into the case through the appropriate opening shown in Installation Drawing (632349 or 643127). Connect the shield only at the recorder end.

Note

Route recorder cable through a separate conduit, not with power cable or alarm output cable.

Cable connections and output selection for potentiometric and current-actuated devices are explained below.

Note

Do not allow internal cable service loop to touch the shock-mounted detector assembly or associated sample inlet and outlet tubing. This precaution ensures against possible transmission of mechanical vibration through the cable to the detector, which could cause noisy readout.

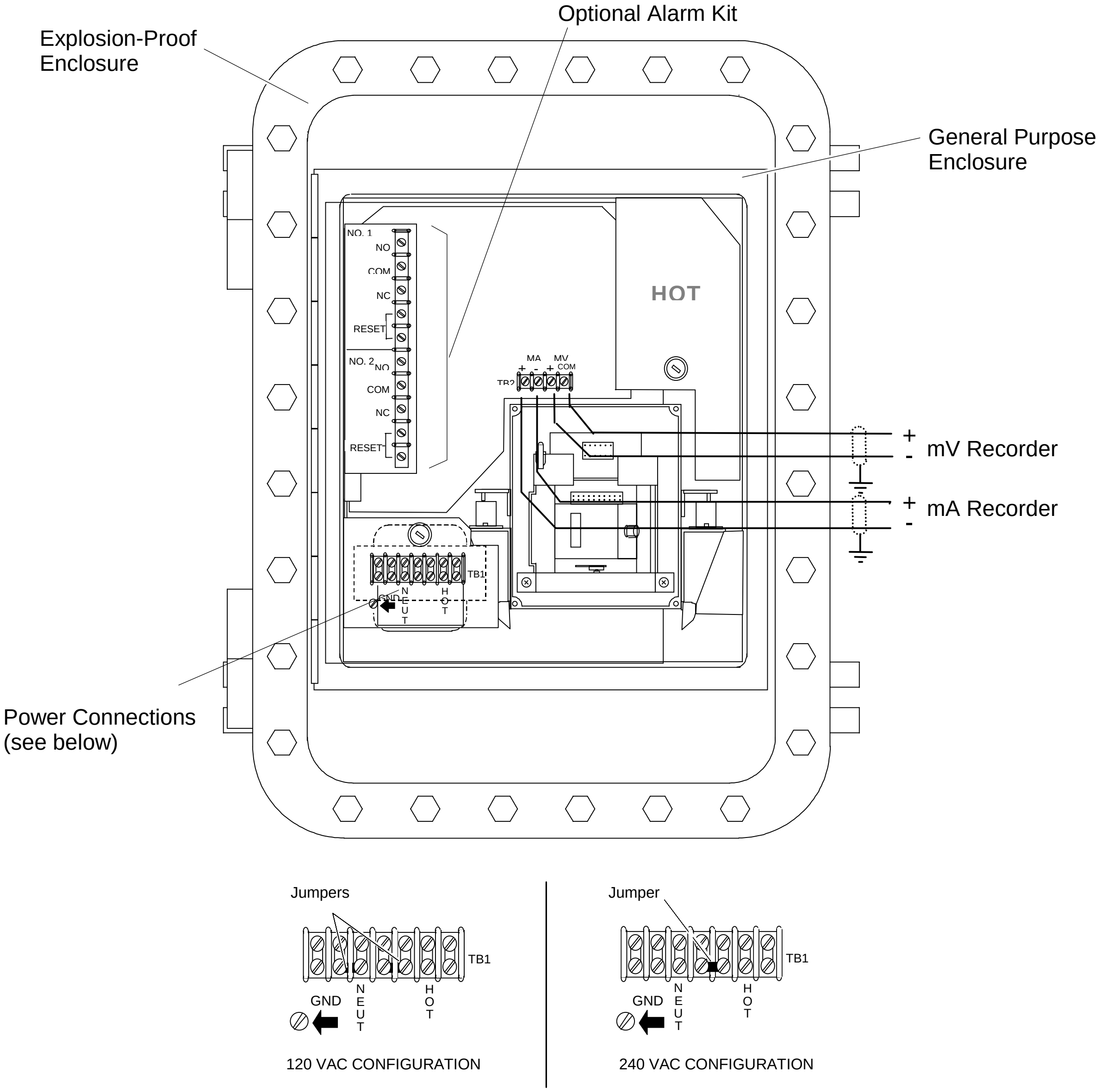


FIGURE 2-1. ELECTRICAL INTERCONNECTION

POTENTIOMETRIC OUTPUT

1. Insert RECORDER OUTPUT Selector Plug (Figure 2-2) in position appropriate to the desired output: 10 mV, 100 mV, 1 V, or 5 V.
2. On TB2, Figure 2-1, connect leads of shielded recorder cable to MV+ and COM terminals.
3. Connect free end of output cable to appropriate terminals of recorder or other potentiometric device:
   a. For device with a span of 0 to 10mV, 0 to 100mV, 0 to 1V, or 0 to 5V, connect cable directly to input terminals of the device, making sure polarity is correct.
   b. For device with intermediate span, i.e., between the specified values, connect cable to device via a suitable external voltage divider, as shown in Figure 2-3.

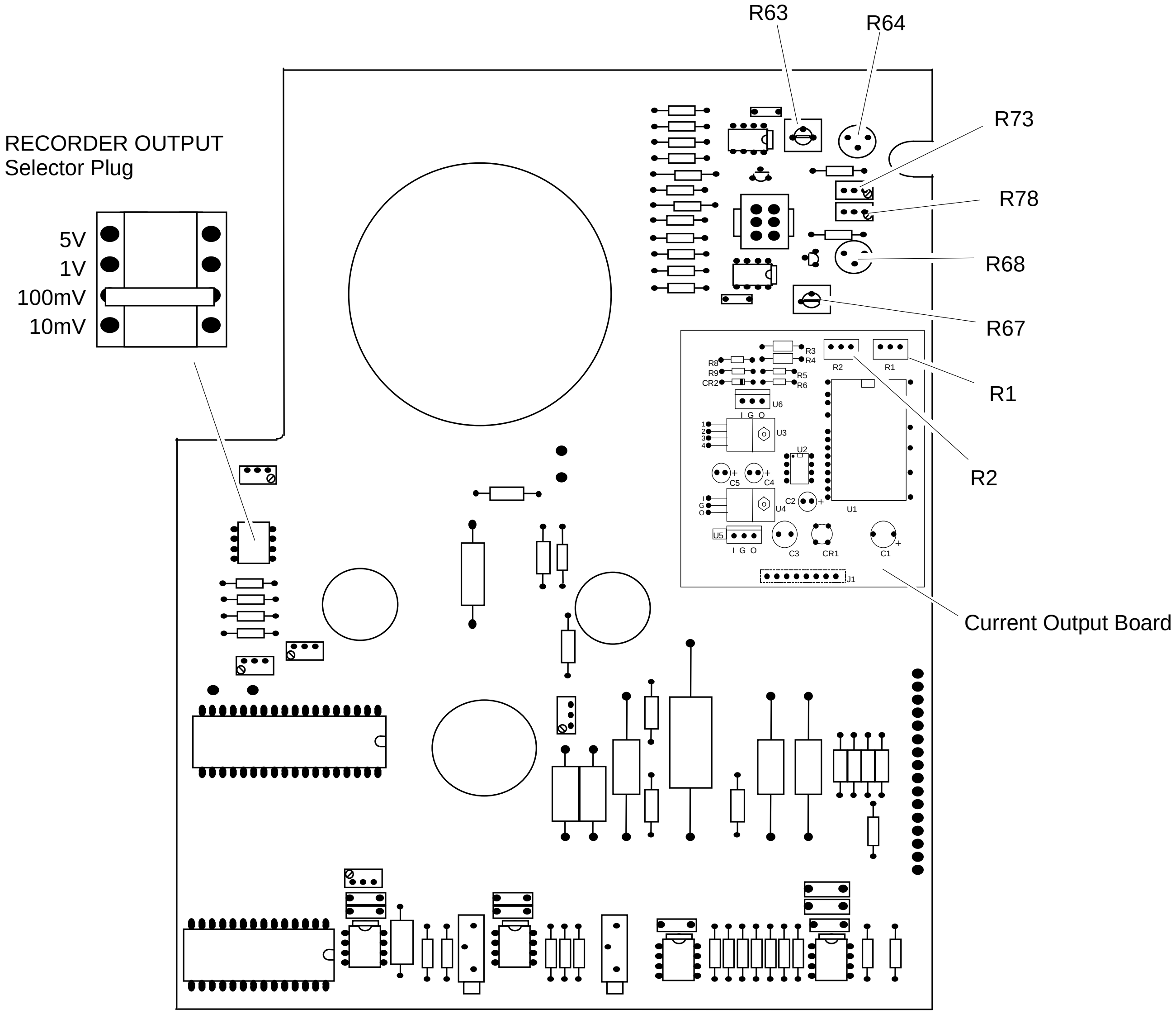
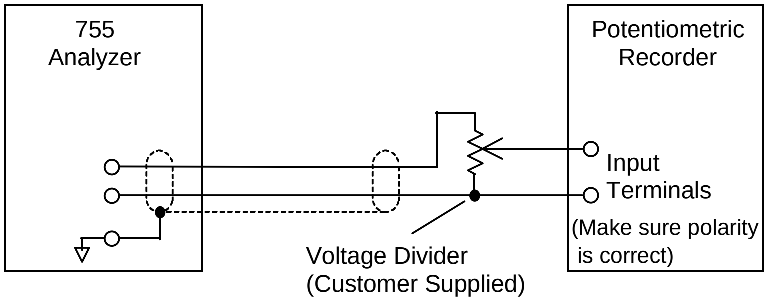


FIGURE 2-2. CONTROL BOARD - ADJUSTMENT LOCATIONS



Position of Recorder Output Selector Plug	Minimum Permissible Resistance for R1 + R2
10 mV	1K Ohm
100 mV	10K Ohm
1 V	100K Ohm
5 V	2K Ohm

FIGURE 2-3. POTENTIOMETRIC RECORDER WITH NON-STANDARD SPAN

ISOLATED CURRENT OUTPUT (OPTION)

The isolated current output board (Figure 2-2) is optional, and can be adjusted for either 0 to 20 mA or 4 to 20 mA. The adjustments made on this board are for zero and span. To set output:

1. With analyzer meter at zero, adjust R1 for desired zero level (typically 0 for 0 to 20 mA, 4 for 4 to 20 mA).
2. With analyzer at fullscale, adjust R2 for desired fullscale current (typically 20 mA).
3. To connect current activated output devices:
4. On TB2, Figure 2-1, connect leads of shielded recorder cable to MA+ and " - " terminals.
5. Connect free end of output cable to input terminals of recorder or other current-actuated device, making sure that polarity is correct. If two or more current-actuated devices are to be used, they must be connected in series, see Figure 2-4. Do not exceed the maximum load resistance (see Section 1.2).
6. For the set up of optional boards, the isolated current output board (optional) can be adjusted for either 0 to 20 mA or 4 to 20 mA. The adjustments made on this board are for zero and span.
   a. With analyzer meter at zero, adjust R1 for desired zero level, typically 0 for 0 to 20 mA, and 4 for 4 to 20 mA.
   b. With analyzer meter at fullscale, adjust R2 for desired fullscale current (typically 20 mA).
7. Current and voltage outputs may be utilized simultaneously, if desired.

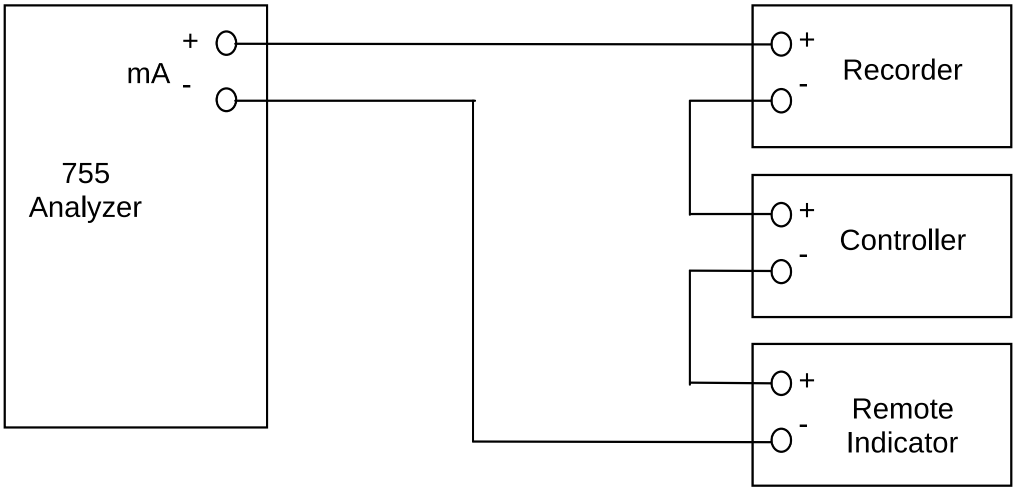


FIGURE 2-4. MODEL 755 CONNECTED TO DRIVE CURRENT OUTPUT-ACTIVATED OUTPUT DEVICES

2.4.3 OUTPUT CONNECTIONS, INITIAL SETUP FOR DUAL ALARM OPTION

If so ordered the analyzer is factory-equipped with alarm output. Alternatively the alarm feature is obtainable by subsequent installation of the Alarm Kit.

ALARM OUTPUT CONNECTIONS

The alarm output provides two sets of relay contacts for actuation of alarm or process-control functions. Leads from the customer-supplied external alarm system connect to terminals on the Alarm Assembly, see Figure 2-1.

Note the following recommendations:

1. A fuse should be inserted into the line between the customer-supplied power supply and the alarm relay terminals on the Alarm Relay Assembly.
2. If the alarm contacts are connected to any device that produces radio frequency interference (RFI), it should be arc-suppressed. The 858728 Arc Suppressor is recommended.
3. If at all possible, the analyzer should operate on a different AC power source, to avoid RFI.

ALARM RELAY CHARACTERISTICS

The Alarm 1 and Alarm 2 outputs of the 638245 Alarm Relay Assembly are provided by two identical single-pole double-throw relays. Relay contacts are rated at:

5 amperes, 240 VAC resistive
1 ampere, 240 VAC inductive
5 amperes, 120 VAC resistive
3 amperes, 120 VAC inductive
5 amperes, 30 VDC resistive
3 amperes, 30 VDC inductive

Removal of AC power from the analyzer, as in power failure, de-energizes both relays, placing them in alarm condition. Switching characteristics of the Alarm 1 and Alarm 2 relays are as follows:

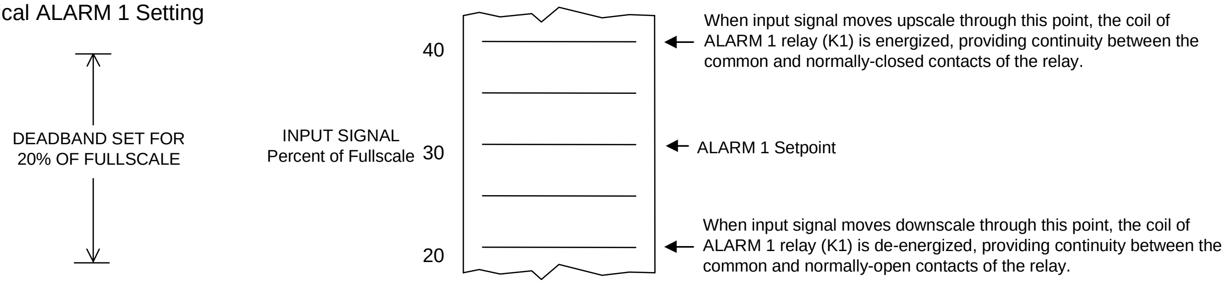
ALARM 1 RELAY

The Alarm I relay coil is de-energized when the meter needle moves downscale through the value that corresponds to setpoint minus dead-band. This relay coil is energized when the needle moves upscale through the value that corresponds to setpoint plus dead-band. See Figure 2-5A.

ALARM 2 RELAY

Relay The Alarm 2 relay coil is de-energized when the meter needle moves upscale through the value that corresponds to the setpoint plus dead-band. This relay coil is energized when needle moves downscale through the value that corresponds to setpoint minus dead-band, see Figure 2-5B.

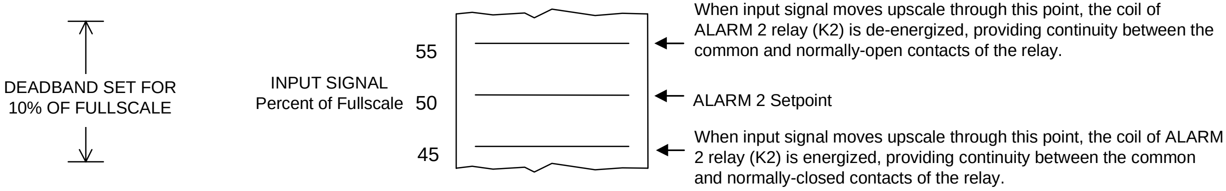
A. Typical ALARM 1 Setting



When input signal moves upscale through this point, the coil of ALARM 1 relay (K1) is energized, providing continuity between the common and normally-closed contacts of the relay.

When input signal moves downscale through this point, the coil of ALARM 1 relay (K1) is de-energized, providing continuity between the common and normally-open contacts of the relay.

B. Typical ALARM 2 Setting



When input signal moves upscale through this point, the coil of ALARM 2 relay (K2) is de-energized, providing continuity between the common and normally-open contacts of the relay.

When input signal moves upscale through this point, the coil of ALARM 2 relay (K2) is energized, providing continuity between the common and normally-closed contacts of the relay.

FIGURE 2-5. TYPICAL ALARM SETTINGS

ALARM RESET

Normally both the ALARM 1 and ALARM 2 functions incorporate automatic rest. When the meter reading goes beyond the selected limits, the corresponding relay is de-energized; when the meter reading returns within the acceptable range, the relay is turned on.

If desired the ALARM 1 or ALARM 2 alarm function may be converted to manual reset. The conversion consists of substituting an external push-button or other momentary-contact switch for the jumper that normally connects the RESET terminals on the Alarm Relay Assembly, see Figure 2-1. If the corresponding relay is now de-energized, i.e., in alarm condition, the relay remains de-energized until the operator momentarily closes the switch.

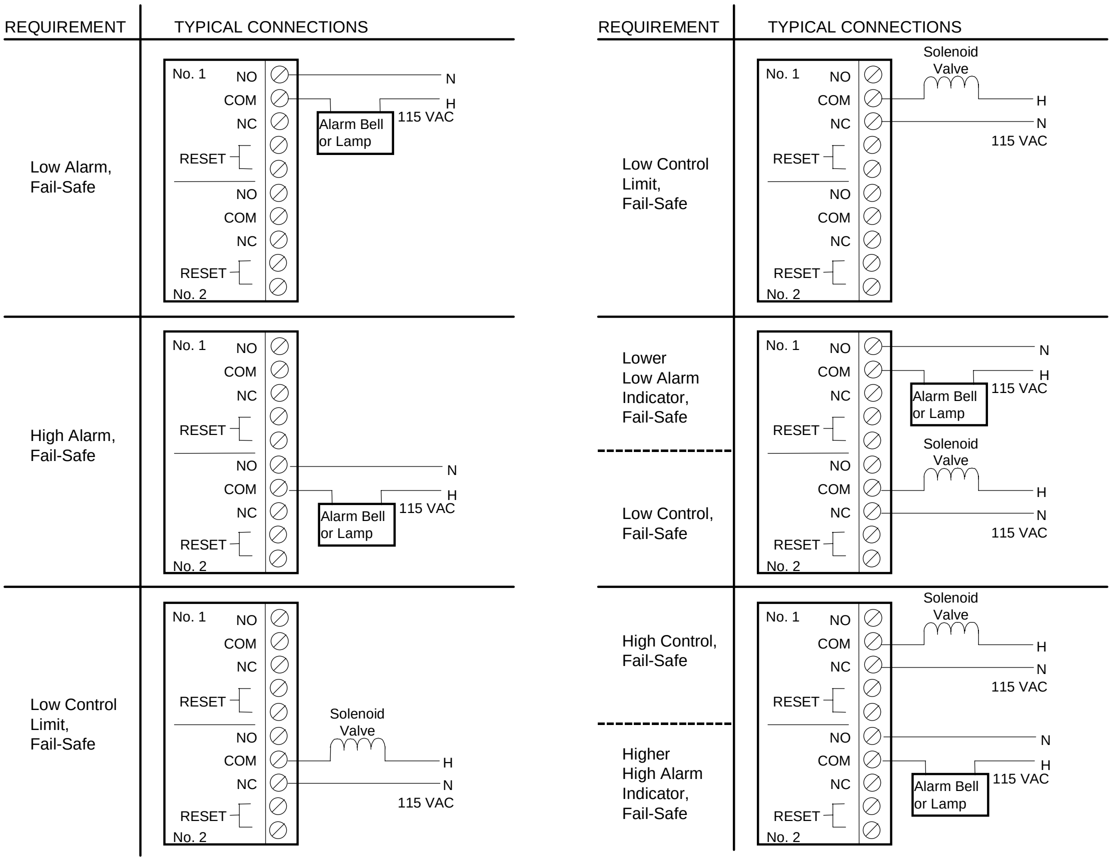


FIGURE 2-6. RELAY TERMINAL CONNECTIONS

FAIL-SAFE APPLICATIONS

By appropriate connection to the double-throw relay contacts, it is possible to obtain either a contact closure or a contact opening for an energized relay. Also either a contact closure or a contact opening may be obtained for a de-energized relay. It is important that for fail-safe applications, the User understand what circuit conditions are desired in event of power failure and the resultant relay de-energization. Relay contacts should then be connected accordingly, see Figure 2-6.

ALARM SETPOINT ADJUSTMENT

The ALARM 1 and ALARM 2 circuits have independent setpoint and dead-band adjustments. Before the ALARM 1 and ALARM 2 setpoints can be set, the alarm dead-band must be calibrated according to the following procedure.

1. Set the front panel TEST switch to position 1.

2. Introduce upscale span gas through analyzer at a flow rate of 50 to 500 cc/min.

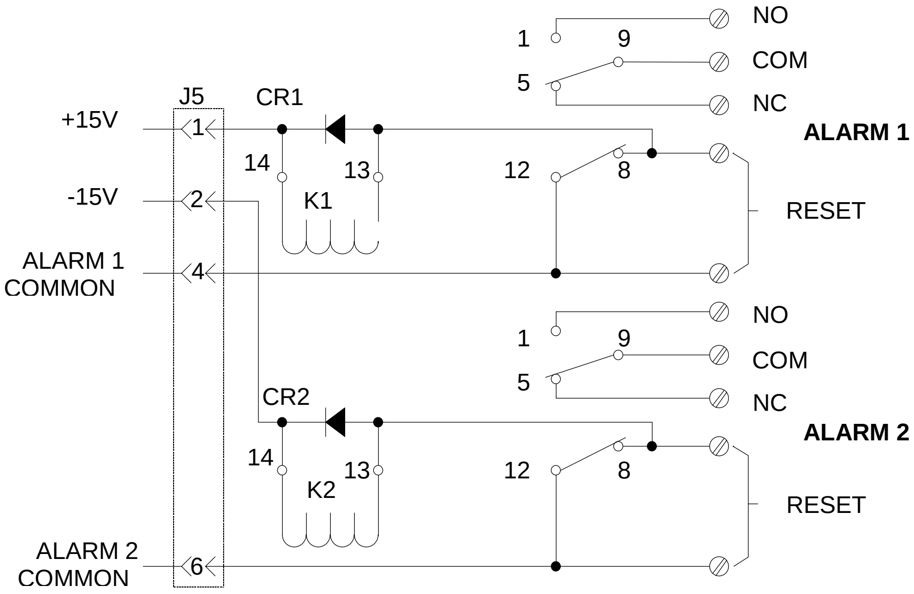
3. Verify that ALARM 1 and ALARM 2 dead-band adjustments, R73 and R78 (Figure 2-2) are turned fully counter-clockwise to set the dead-band at minimum. Normally these potentiometers are factory-set for minimum dead-

band. Both potentiometers must remain at this setting throughout calibration of the alarm setpoint adjustments.

4. Connect an ohmmeter to relay terminals on 638254 Alarm Relay Assembly to verify when alarms have been energized.

5. Calibration of ALARM 1, HIGH.

   a. Rotate setpoint adjustment, R64, fully counter-clockwise.
   b. Adjust SPAN control to give a display or recorder reading exactly fullscale. If the fullscale setting cannot be reached, set to a reading higher than the desired alarm setpoint.
   c. Set ALARM 1 calibration adjustment, R63, to its clockwise limit (Figure 2-2). Rotate R63 counter-clockwise the minimum amount required to energize ALARM 1, relay K1. Verify that the alarm has been energized with the ohmmeter on the relay contacts (Figure 2-7).



2. RELAYS SHOWN IN ENERGIZED POSITION.
1. CR1 AND CR2 ARE ANY 600 V, 1 AMP DIODE.
NOTES:

FIGURE 2-7. ALARM RELAY OPTION SCHEMATIC DIAGRAM

6. Calibration of ALARM 2, LOW.

   a. Rotate setpoint adjustment, R68, fully counter-clockwise.

b. Adjust SPAN control for display or recorder reading exactly fullscale. If the fullscale setting cannot be reached, then set to a reading higher than the desired alarm setpoint.

c. Set ALARM 2 calibration adjustment, R67, to its clockwise limit. Rotate R67 counter-clockwise, the minimum amount required to energize ALARM 2, relay K2. Verify that the alarm has been energized with the ohmmeter on the relay contacts (Figure 2-7).

7. Setpoint adjustment of ALARM 1, HIGH.

a. With span gas flowing, adjust SPAN control to read desired alarm setpoint on display or recorder.

b. Rotate setpoint adjustment, R64, clockwise to energize relay.

c. Check this setting by adjusting the SPAN control to lower the output below the setpoint. This will de-energize the relay. Rotating R64 above the setpoint will energize the relay.

8. Setpoint adjustment of ALARM 2, LOW.

a. With span gas flowing, adjust the SPAN control to read desired alarm setpoint on display or recorder.

b. Rotate setpoint adjustment, R68, clockwise to energize relay.

c. Check setting by adjusting the SPAN control to lower the output below the setpoint. This will energize the relay. Rotating R68 above the setpoint will de-energize the relay.

2.5 CALIBRATION GASES

WARNING: HIGH PRESSURE GAS CYLINDERS

Calibration gas cylinders are under pressure. Mishandling of gas cylinders could result in death, injury, or property damage. Handle and store cylinders with extreme caution and in accordance with manufacturer instructions. Refer to General Precautions for Handling and Storing High Pressure Gas Cylinders, in the rear of this manual.

Analyzer calibration consists of establishing a downscale calibration point and an upscale calibration point.

Downscale calibration may be performed on a range that will be used during sample analysis. For maximum precision, however, it should be performed on the range of highest sensitivity, i.e., most narrow span.

Preferably upscale calibration should be performed on a range to be used in sample analysis. In some applications, however, it may be desirable to perform upscale calibration on a range of higher sensitivity, i.e., more narrow span, and then move the % RANGE switch to the desired operating range. For example, if the operating range is to be 0 to 50% oxygen, upscale calibration may be performed on the 0 to 25% range to permit use of air as the upscale standard gas.

Recommendations on calibration gases for various operating ranges are tabulated in Table 2-1 and are explained in Sections 2.5.1 and 2.5.2.

Each standard gas should be supplied from a cylinder equipped with dual-stage metal-diaphragm type pressure regulator, with output pressure adjustable from 0 to 50 psig (0 to 34.5 kPa).

A. ZERO BASED RANGES

RANGE % O_2	RECOMMENDED DOWNSCALE STANDARD GAS	RECOMMENDED UPSCALE STANDARD GAS
0 to 1	Nitrogen	0.9% O_2, balance N_2
0 to 2.5	Nitrogen	2.3% O_2, balance N_2
0 to 5	Nitrogen	4.5% O_2, balance N_2
0 to 10	Nitrogen	9% O_2, balance N_2
0 to 25	Nitrogen	Air (20.93% O_2)
0 to 50	Nitrogen	0.45% O_2, balance N_2
0 to 100	Nitrogen	100% O_2

B. ZERO SUPPRESSED RANGES

RANGE % O_2	RECOMMENDED DOWNSCALE STANDARD GAS	RECOMMENDED UPSCALE STANDARD GAS
90 to 100	91% 0.5% O_2, balance N_2	High-purity O_2
80 to 100	82% 1% O_2, balance N_2	100% O_2
60 to 100	62% 1% O_2, balance N_2	100% O_2
50 to 100	52% 1% O_2, balance N_2	100% O_2

Note

Each standard gas used should have a composition within the specified limits, and should have a certified analysis provided by the supplier.

TABLE 2-1. CALIBRATION RANGE FOR VARIOUS OPERATING RANGES

2.5.1 DOWNSCALE STANDARD GAS

In the preferred calibration method described in Section 3.2.1, a suitable downscale standard gas is used to establish a calibration point at or near the lower range-limit. Composition of the downscale standard depends on the type of range:

A zero based range normally uses an oxygen-free zero gas, typically nitrogen.

A zero-suppressed range uses a blend consisting of a suitable percentage of oxygen contained in a background gas. typically nitrogen.

(An alternative calibration method, described in Section 3.2.2, uses an upscale standard gas only and does not require a downscale standard gas.)

2.5.2 UPSCALE STANDARD GAS

A suitable upscale standard gas is required to establish a calibration point at or near the upper range limit. If this range limit is 215% or 25% oxygen, the usual upscale standard gas is air (20.93% oxygen).

2.6 SAMPLE HANDLING

Basic requirements for sample handling are:

- Particulate filter, inserted into the sample line immediately upstream from the analyzer inlet. A 2-micron filter is recommended to ensure against damage to the test body and associated internal diffusion screen within the detector assembly.
- Provision for pressurizing the sample gas to provide flow through the analyzer. Special applications may use a suction pump to draw sample through the analyzer.
- Provision for selecting sample, downscale standard, or upscale standard gas for admission to the analyzer, and for measuring the flow of the selected gas. Typically these functions are provided by a gas selector panel available as an accessory. A typical gas selector panel, is shown in Figure 2-8.

Many different sample-handling systems are available depending on the requirements of the individual user. Most sample-handling systems have copper or brass components; however stainless-steel components are available for applications involving corrosive gases. With corrosive gases, complete drying of the sample is desirable, as most of these gases are practically inert when totally dry. For specific corrosive applications, consult the factory.

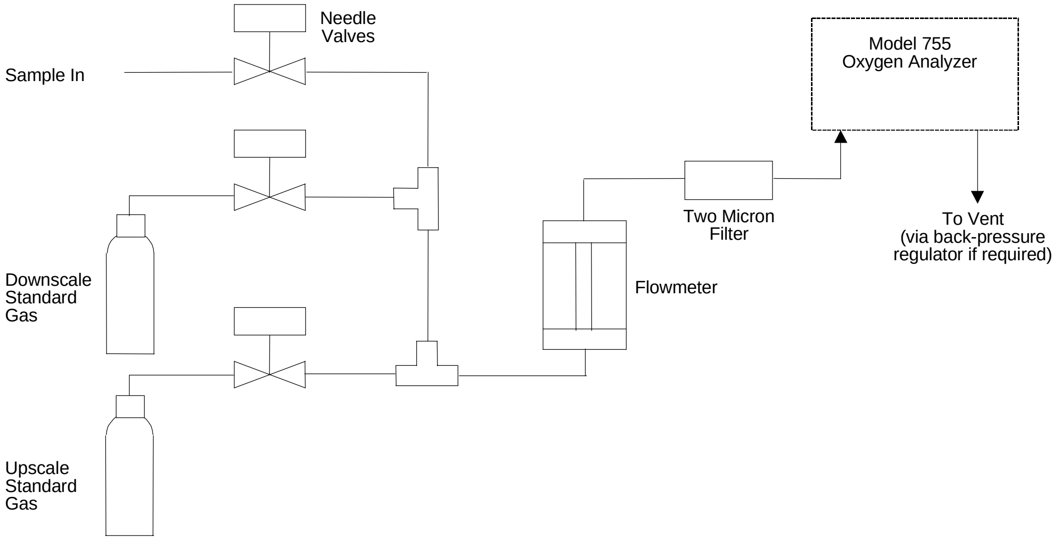


FIGURE 2-8. CONNECTION OF TYPICAL GAS SELECTOR PANEL TO MODEL 755

2.6.1 SAMPLE TEMPERATURE REQUIREMENTS

Sample temperature at the analyzer inlet should be in the range of 50°F to 150°F (10°C to 66°C).

With a thoroughly dry sample, entry temperature can be as high as 150°F (66°C) without affecting readout accuracy. Normally however a maximum entry temperature of 110°F (43°C) is recommended so that the sample temperature will rise during passage of the sample through the analyzer. This precaution ensures against cooling of the sample and possible condensation of moisture. Such condensation should be avoided as it may damage the detector.

2.6.2 SAMPLE PRESSURE REQUIREMENTS: GENERAL

Operating pressure limits are as follows: Maximum, 10 psig (69 kPa gauge pressure); minimum, 660 mm Hg absolute (88.1 kPa absolute pressure).

CAUTION: OPERATION LIMITS

Operation outside the specified limits may damage the detector, and will void the warranty.

The basic rule for pressure of sample and standard gases supplied to the inlet is to calibrate the analyzer at the same pressure that will be used during subsequent operation, and to maintain this pressure during operation. The arrangement required to obtain appropriate pressure control will depend on the application. When inputting sample or calibration gases, use the same pressure that will be used during subsequent operation, refer to Section 2.6.3, Normal Operation at Positive Gauge Pressures; or Section 2.6.4, Operation at Negative Gauge Pressure.

2.6.3 NORMAL OPERATION AT POSITIVE GAUGE PRESSURES

PRESSURE AT SAMPLE INLET

Normally the sample is supplied to the analyzer inlet at a positive gauge pressure in the range of 0 to 10 psig (0 to 69 kPa).

CAUTION: HIGH PRESSURE SURGES

High pressure surges during admission of sample or standard gases can damage the detector.

SAMPLE EXHAUST

With positive sample pressure, the proper choice of arrangement for sample exhaust depends principally on whether the analyzer has zero-based or zero-suppressed ranges. as explained below.

SAMPLE EXHAUST ARRANGEMENTS FOR ZERO-BASED RANGES

With zero-based ranges, the analyzer exhaust port is commonly vented directly to the atmosphere, and any change in barometric pressure results in a directly proportional change in the indicated percentage of oxygen.

EXAMPLE

Range, 0% to 5% O2
Barometric pressure change after calibration, 1%
Instrument reading, 5% O2
Readout error = 0.01 x 5% O2 = 0.05% O2
Fullscale span is 5% O2, therefore the 0.05% O2 error is equal to 1% fullscale.

Thus if the exhaust is vented to the atmosphere, the pressure effect must be taken into consideration. This may be accomplished in various ways: manual computation, computer correction of data. etc.

2.6.4 OPERATION AT NEGATIVE GAUGE PRESSURES

Operation at negative gauge pressures is not normally recommended but may be used in certain special applications. A suction pump is connected to the analyzer exhaust port to draw sample into the inlet and through the analyzer. Such operation necessitates special precautions to ensure accurate readout. There is the basic consideration of supplying the standard gases to the analyzer at the same pressure that will be used for the sample during subsequent operation. In addition, any leakage in the sample-handing system will result in decreased readout accuracy as compared with operation at atmospheric pressure.

The minimum permissible operating pressure is 660 mm Hg absolute (88.1 kPa absolute). Operation below this limit may damage the detector and will void the warranty.

2.6.5 SAMPLE FLOW RATE

Operating limits for sample flow rate are as follows: Minimum, 50 cc/min; maximum, 500 cc/min. A flow rate of less than 50 cc/min is too slow to sweep out the detector and associated flow system efficiently, it will therefore allow the incoming sample to mix with earlier sample, causing an averaging or damping effect. Too rapid a flow will cause a back pressure that will affect the reading. The optimum flow rate is between 200 and 300 cc/min.

Deviation from the set flow should be held to within ±10% or ±20 cc/min, whichever is smaller. If so, zero and span will be within the limits given on the specifications page, provided that operating pressure remains constant.

BYPASS FLOW

Preferably the analyzer should be installed near the sample source to minimize transport time. Otherwise time lag may be appreciable. For example, assume that sample is supplied to the analyzer via a 100-foot (30.5 m) length of 1/4-inch (6.35 mm) tubing. With a flow rate of 100 cc/min, sample transport time is approximately 6 minutes.

Sample transport time may be reduced by piping a greater flow than is required to the analyzer and then routing only the appropriate portion of the total flow through the analyzer. The unused portion of the sample may be returned to the stream or discarded.

2.6.6 CORROSIVE GASES

In applications where the sample stream contains corrosive gases. a complete drying of the sample is desirable. as most of these gases are practically inert when totally dry. For corrosive applications, consult the factory.

WARNING: RADIOACTIVE SAMPLE GASES

Radioactive sample gases will attack the rubber sample tubing within the analyzer, causing deterioration at a rate proportional to the level of radioactivity. In applications involving radioactive samples, the internal tubing should be examined periodically and replaced as required. Failure to observe this precaution can result in leakage of radioactive sample into the ambient atmosphere.

2.7 LEAK TEST

Supply air or inert gas such as nitrogen at 10 psig (69 kPa) to analyzer via a flow indicator with range of 0 to 250 cc/min. Set flow at 125 cc/min. Plug sample outlet. Flow reading should drop to zero. If not, the system is leaking.

WARNING: POSSIBLE EXPLOSION HAZARD

If explosive gases are introduced into this analyzer, the sample containment system must be carefully leak-checked upon installation and before initial start-up, during routine maintenance and any time the integrity of the sample containment system is broken, to ensure the system is in leak-proof condition. Internal leakage of sample resulting from failure to observe these precautions could result in an explosion causing death, personal injury, or property damage.

Leakage must be corrected before introduction of flammable sample or application of electrical power. Liberally cover all fittings, seals, and other possible sources of leakage with suitable leak test liquid such as Snoop (P/N 837801). Bubbling or foaming indicates leakage. Checking for bubbles will locate most leaks but could miss some because some areas are inaccessible to application of Snoop. For positive assurance that system is leak-free, use the flow stoppage test.

2.8 PURGE KIT (OPTIONAL)

The optional 643108 Purge Kit is designed to equip the Model 755 General Purpose enclosure with Type Z Air Purge per National Fire Protection Association Standard NFPA 496-1986, Chapter Two. The kit, along with user-supplied components, when installed as described in these instructions, is designed to reduce the classification within the enclosure from Division 2 (normally non-hazardous) to non-hazardous.

⚠ *WARNING: POSSIBLE EXPLOSION HAZARD*

The general purpose Model 755 Oxygen Analyzer, catalog number 191102, is for operation in non-hazardous locations. It is of a type capable of analysis of sample gases which may be flammable. If used for analysis of such gases, the instrument must be protected by a continuous dilution purge system in accordance with Standard ANSI/NFPA-496-1086 (Chapter 8) or IEC Publication 79-2-1983 (Section Three).

If explosive gases are introduced into this analyzer, the sample containment system must be carefully leak-checked upon installation and before initial start-up, during routine maintenance and any time the integrity of the sample containment system is broken, to ensure the system is in leak-proof condition.

Internal leakage of sample resulting from failure to observe these precautions could result in an explosion causing death, personal injury, or property damage.

This kit is designed only for protection against the invasion of flammable gases into the enclosure from the outside atmosphere. It does not cover protection from possible abnormal release (leakage) of flammable gases intentionally introduced into the enclosure.

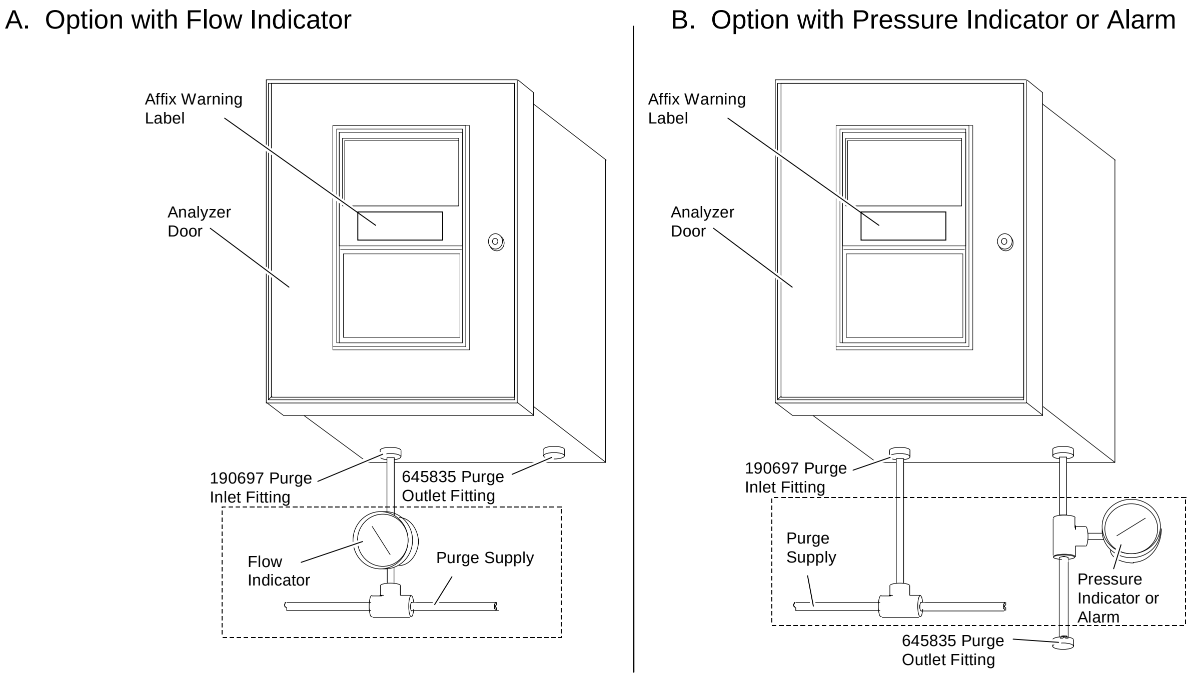
This kit consists of the following items:

PART NO.	DESCRIPTION
190697	Purge Inlet Fitting
045835	Purge Outlet Fitting
002787	Warning label
856156	Sealant (Duxseal)

Note: To conform to NFPA Type Z requirements, the warning label must be applied to the analyzer front cover. If the analyzer is ordered factory equipped with purge kit, this label is applied at the factory.

Installation options are shown in Figure 2-9. Use only clear dry air or suitable inert gas for the purge supply. Recommended supply pressure is 20 psig (138 kPa, which provides a flow of approximately 8 cubic feet per hour (approximately 4 liters per minute), and a case pressure of approximately 0.2 inch of water (approximately 50 Pa). With a flow rate of four liters per minute, four case volumes of purge gas pass through the case in ten minutes.

All conduit connections through the case must be sealed thoroughly with a sealant (supplied in kit). The sealant, to be applied from the interior of the case, must thoroughly cover all exiting leads as well as the conduit fitting.



A. Option with Flow Indicator

B. Option with Pressure Indicator or Alarm

Components in dashed line are supplied by customer.

FIGURE 2-9. INSTALLATION OF PURGE KIT

NOTES

3

STARTUP

Preparatory to start-up and calibration, a familiarization with Figures 1-1, 1-2 and 3-1, and Tables 3-1 is recommended. These figures give locations and summarized descriptions of components and operating adjustments of the Model 755.

Open analyzer door and verify that circuit boards are properly installed and connected. Verify proper connection of electrical cables, see Figure 2-1.

3.1 START-UP PROCEDURE

WARNING: POSSIBLE EXPLOSION HAZARD

If explosive gas samples are introduced into the analyzer, it is recommended that sample containment system fittings and components be thoroughly leak checked prior to initial application of electrical power, routinely on a periodic basis thereafter, and after any maintenance which entails breaking the integrity of the sample containment system. Leakage of flammable sample gas could result in an explosion.

Pass suitable on-scale gas (not actual sample) through the analyzer. Turn on power. If meter drives off-scale in either direction, the probable cause is hang-up of the suspension within the detector assembly. To correct this condition, turn off power, tap detector compartment with fingers, wait 30 seconds, then again apply power.

When on-scale reading is obtained, allow analyzer to warm up for at least one hour with gas flowing. This warm-up is necessary because a reliable calibration is obtainable only after the analyzer reaches temperature stability. Moreover the resultant elevated temperature will ensure against condensation within, and possible damage to, the detector assembly.

After analyzer warm-up, the meter or recorder should give stable,, drift-free readout. If so, proceed to Section 3.2. Otherwise refer to Section 7, Service and Maintenance.

3.2 CALIBRATION

Calibration consists of establishing a downscale calibration point and an upscale calibration point, see Table 3-3. Downscale calibration may be performed on the range that will be used during sample analysis. For maximum precision however, it should be performed on the range of highest sensitivity, i.e., most narrow span. Preferably upscale calibration should be performed on the range that will be used during sample analysis. In some applications however, it may be desirable to perform upscale calibration on a range of higher sensitivity, i.e., more narrow span, and then move the % RANGE Switch to the desired operating range. For example, if the operating range is to be 0 to 50% oxygen upscale calibration may be performed on the 0 to 25% range, to permit use of air as the upscale standard gas.

It is necessary to calibrate the instrument at the same pressure that will be used during subsequent operation and to maintain this pressure during operation.

The preferred calibration method uses both a downscale and an upscale standard gas, as described in Section 3.2.1. An alternative method using an upscale standard gas only is described in Section 3.2.2.

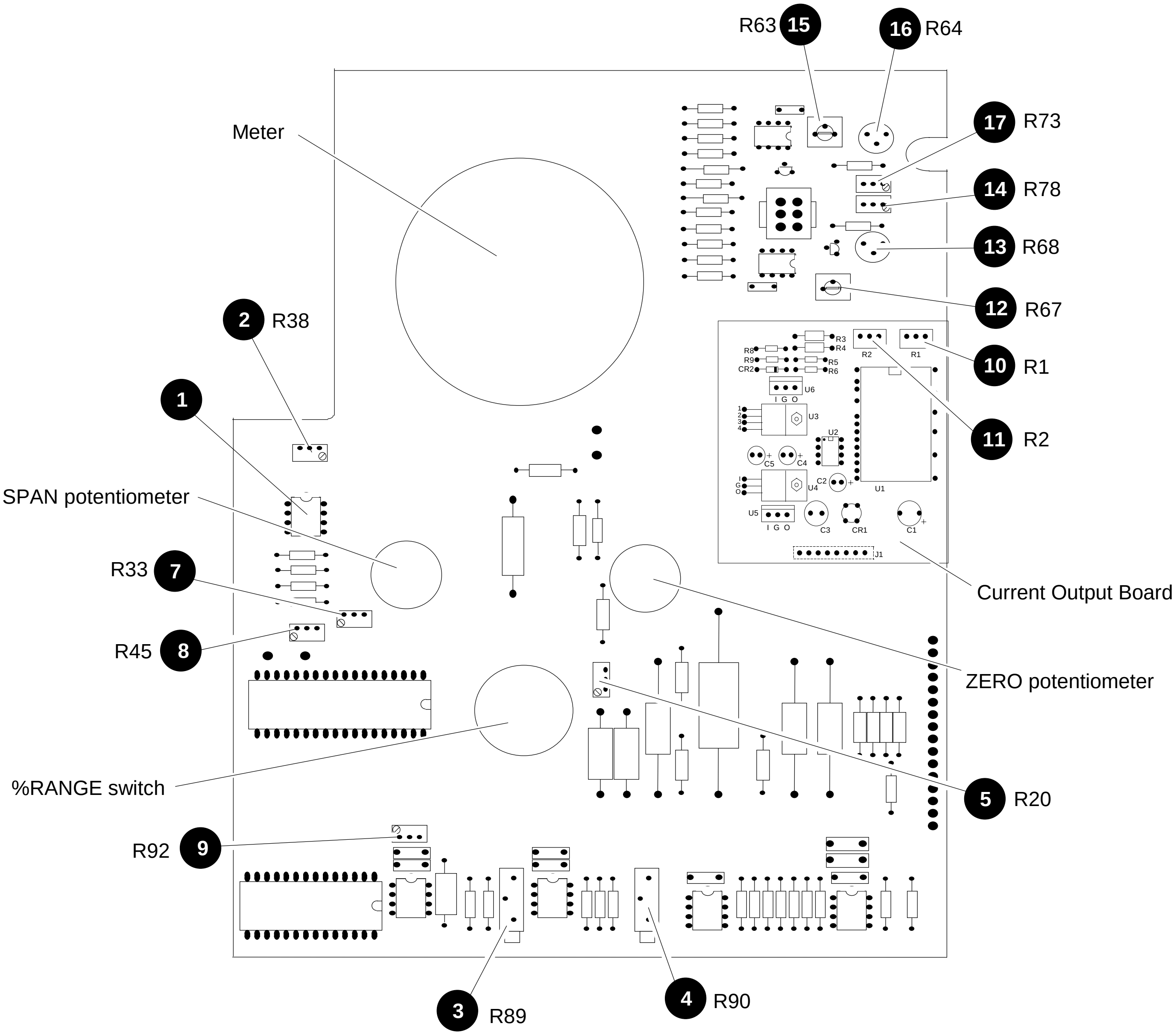


FIGURE 3-1. CONTROL BOARD - ADJUSTMENT LOCATIONS

ADJUSTMENT	FUNCTION
1. RECORDER OUTPUT (SELECTOR PLUG)	Provides selectable output of 10 mV 100 mV, 1 V, or 5 V for a voltage recorder.
2. METER ADJUSTMENT (R38)	Used to set meter to agree with recorder.
3. AMPLIFIER AR3 ZERO ADJUSTMENT (R89)	Used for initial factory zeroing of amplifier AR3. (With slider of front-panel SPAN potentiometer R4 connected to ground, R89 is adjusted for zero.)
4. AMPLIFIER AR4 ZERO ADJUSTMENT (R90)	Used for initial factory zeroing of amplifier AR4. (With R10 connected to ground, R90 is adjusted for zero.)
5. RESPONSE TIME ADJUSTMENT (R20)	Provides adjustment range of 5 to 25 seconds for electronic response time (0 to 90% of fullscale). Clockwise adjustment decreases response time.
6.	
7. +5 VDC FULLSCALE OUTPUT ADJUSTMENT (R33)	Used to set fullscale for basic analyzer output at +5 VDC.
8. ZERO SUPPRESSION ADJUSTMENT (R45)	Used to set appropriate zero offset for suppressed-zero ranges.
9. DETECTOR COARSE ZERO ADJUSTMENT (R92)	Provides coarse adjustment of detector zero by shifting the position of the detector within the magnetic field. It is adjusted during factory checkout, and does not require readjustment except after replacement of detector.
10. CURRENT OUTPUT ZERO ADJUSTMENT (R1)	Used to set zero-level current output, i.e., 4 mA for 4 to 20 mA board, 0 mA for 0 to 20 mA board, or 10 mA for 10 to 50 mA board.
11. CURRENT OUTPUT SPAN ADJUSTMENT (R2)	Used to set fullscale current output at 20 mA for 4 to 20 or 0 to 20 mA board, or at 50 mA for 10 to 50 mA board.
12. ALARM 2 CALIBRATION ADJUSTMENT (R67)	Used for initial calibration of ALARM 2 circuit.
13. ALARM 2 SET-POINT ADJUSTMENT (R68)	Provides continuously variable adjustment of setpoint for ALARM 2 circuit on optional alarm accessory, for actuation of external, customer-supplied alarm and/or control device(s). Adjustment range is 0 to 100% of fullscale span.
14. ALARM 2 DEADBAND ADJUSTMENT (R78)	Permits adjusting deadband of ALARM 2 circuit from 1% of fullscale (counterclockwise limit) to 20% of fullscale (clockwise limit). Deadband is essentially symmetrical with respect to setpoint.
15. ALARM 1 CALIBRATION ADJUSTMENT (R63) ***16. ALARM 1 SETPOINT ADJUSTMENT (R64)*** ***17. ALARM 1 DEADBAND ADJUSTMENT (R73)***	Functions identical to the corresponding adjustment for ALARM 2 circuit.

TABLE 3-1. CONTROL BOARD - ADJUSTMENT FUNCTIONS

A. ZERO BASED RANGES

RANGE % O_2	RECOMMENDED DOWNSCALE STANDARD GAS	RECOMMENDED UPSCALE STANDARD GAS
0 to 1	Nitrogen	0.9% O_2, balance N_2
0 to 2.5	Nitrogen	2.3% O_2, balance N_2
0 to 5	Nitrogen	4.5% O_2, balance N_2
0 to 10	Nitrogen	9% O_2, balance N_2
0 to 25	Nitrogen	Air (20.93% O_2)
0 to 50	Nitrogen	0.45% O_2, balance N_2
0 to 100	Nitrogen	100% O_2

B. ZERO SUPPRESSED RANGES

RANGE % O_2	RECOMMENDED DOWNSCALE STANDARD GAS	RECOMMENDED UPSCALE STANDARD GAS
90 to 100	91% 0.5% O_2, balance N_2	High-purity O_2
80 to 100	82% 1% O_2, balance N_2	100% O_2
60 to 100	62% 1% O_2, balance N_2	100% O_2
50 to 100	52% 1% O_2, balance N_2	100% O_2

Note

Each standard gas used should have a composition within the specified limits, and should have a certified analysis provided by the supplier.

TABLE 3-2. CALIBRATION RANGE FOR VARIOUS OPERATING RANGES

3.2.1 CALIBRATION WITH DOWNSCALE AND UPSCALE STANDARD GASES

Set downscale calibration point as follows:

a. Set % RANGE Switch in a position appropriate to the selected standard gases. The switch may be set for the range to be used during sample analysis. For maximum precision however, it should be set for the range of highest sensitivity, i.e., most narrow span.

b. Pass downscale standard gas through analyzer at suitable flow rate preferably 250 cc/min. Allow gas to purge analyzer for minimum of three minutes.

c. Adjust ZERO Control so that reading on meter or recorder is appropriate to the downscale standard gas. (The required reading may be the actual oxygen content of the downscale standard gas, or may be an adjusted value, depending on the relative magnetic susceptibilities involved, and the range and span used, see Section 3.3.2.) If proper reading is unobtainable by an adjustment of the ZERO Control, refer to Section 7, Service and Maintenance.

d. If previous reading was obtained on a recorder, set Meter Adjustment R38, see Figure 3-1, so that meter reading agrees with recorder setting.

2. Set upscale calibration point as follows:

   a. Set % RANGE Switch in position appropriate to the selected upscale standard gas.

b. Pass upscale standard gas through analyzer at same flow rate as was used for downscale standard gas. Allow gas to purge analyzer for minimum of three minutes.

c. Adjust SPAN Control so that reading on meter or recorder is appropriate to the upscale standard gas. (The required reading may be the actual oxygen content of the upscale standard gas, or may be an adjusted value, depending on the relative magnetic susceptibilities involved, and the range and span used, see Section 3.2.2.) If proper reading is unobtainable by adjustment of the SPAN Control, refer to Section 7, Service and Maintenance.

3.2.2 ALTERNATIVE CALIBRATION PROCEDURE USING UPSCALE STANDARD GAS ONLY

The following calibration procedure, using an upscale standard gas only, is an alternative to the calibration procedure described in Section 3.2.1, which requires both a downscale and an upscale standard gas.

Throughout the procedure it is preferable to use recorder readout for all oxygen readings.

If a recorder is not available, use the front-panel meter.

1. Set % RANGE Switch for range of highest sensitivity, i.e., most narrow span.
2. Set ZERO and SPAN Controls at mid-range.
3. Pass upscale standard gas through analyzer at suitable flow rate, preferably 250 cc/min. Allow gas to purge analyzer for minimum of three minutes.
4. With % RANGE Switch set for most-sensitive range, obtain reading equal to the oxygen content of the upscale standard gas by adjustment of the appropriate control:
    a. If the most-sensitive range is zero-suppressed, obtain the correct reading by adjustment of internal Zero Suppression Potentiometer R45, see Figure 3-1.
    b. If the most-sensitive range is zero-based, or if a stable reading is unobtainable by adjustment of R45, obtain correct reading by adjustment of ZERO control.
5. Set % RANGE Switch for least-sensitive range, i.e., widest span. Then adjust SPAN Control to obtain reading equal to the oxygen concentration of the upscale standard gas. Return % RANGE Switch to most-sensitive range.
6. Repeat Steps 4b and 5 as many times as necessary until no readjustment is required after switch-over from one range to the other.
7. To verify accurate calibration, admit an on-scale gas other than the upscale standard. and check that the indicated oxygen concentration is correct.

EXAMPLE

Range, 90% to 100% *oxygen*

Upscale Standard Gas, 99.7% *oxygen*

8. Set % RANGE Switch for 90% to 100% oxygen. Then adjust SPAN Control for recorder reading of 99.7% oxygen. Return % RANGE Switch to 99% to 100% range.
9. Repeat Steps 4b and 5 as many times as necessary until recorder reads 99.7% oxygen regardless of position of % RANGE Switch.
10. Admit a gas containing a known concentration of oxygen in the range of 90% to 100% oxygen. Verify that the recorder indicates the correct value.
11. Pass upscale standard gas through analyzer at 250 cc/min. Allow gas to purge analyzer for minimum of 3 minutes.
12. Obtain recorder reading of 99.7% oxygen, by adjustment of (a) R45 and, if necessary, (b) ZERO Control.

3.3 COMPENSATION FOR COMPOSITION OF BACKGROUND GAS

Any gas having a composition other than 100% oxygen contains background gas. The background gas comprises all non-oxygen constituents. Although instrument response to most gases other than oxygen is comparatively slight, it is not in all cases negligible. Contribution of these components to instrument response is a function of the span and range used, and can be computed for each individual case.

If the downscale and upscale standard gases contain the same background gas as the sample, the routine standardization procedure automatically compensates for the background components: therefore, they introduce no error.

If the background gas in the sample is different from that in the downscale and/or upscale standard gas(es) background effects must be taken into consideration to ensure correct readout. During adjustment of the front-panel ZERO and SPAN Controls, the instrument is set to indicate not the true oxygen content of the downscale and upscale standard gases, but slightly different values, calculated to provide correct readout during subsequent analysis of the sample gas. The calculations are explained in Section 3.3.2.

3.3.1 OXYGEN EQUIVALENT VALUES OF GASES

For computation of background corrections, the analyzer response to each component of the sample must be known. Table 3-3 lists the percentage oxygen equivalent values for many common gases. The percentage oxygen equivalent (POE) of a gas in the instrument response to the given gas compared to the response to oxygen, assuming that both gases are supplied at the same pressure, can be calculated using the following equation:

To select a random example from Table 3-4, if analyzer response to oxygen is +100%, the response to xenon would be -1.34%.

OXYGEN EQUIVALENTS OF GAS MIXTURES

The oxygen equivalent of a gas mixture is the sum of the contributions of the individual gas components.

EXAMPLE: ZERO-BASED RANGE

At lower range-limit, i.e., 0% oxygen composition of sample is: 80% CO_2, 20% N_2.

From Table 3-4, the % oxygen equivalents are: CO_2, -0.623%, N_2, -0.358%.

% oxygen equivalent of mixture

= 0.8 x (-0.623) + 0.2 x (-0.358)
= (-0.4984) + (-0.07l6)
= 0.570% O_2

GAS	EQUIV. % AS
Acetylene, C_2H_2	-0.612
Allene, C_3H_4	-0.744
Ammonia, NH_3	-0.479
Argon, A	-0.569
Bromine, Br_2	-1.83
1,2-Butadiene C_4H_6	-1.047
1,3-Butadiene C_4H_6	-1.944
n-Butane, C_4H_{10}	-1.481
iso-Butane, C_4H_{10}	-1.485
Butene-1, C_4H_8	-1.205
cis Butene-2, C_4H_8	-1.252
iso-Butene, C_4H_8	-1.201
trans butene-2, C_4H_8	-1.274
Carbon Dioxide CO_2	-0.623
Carbon Monoxide, CO	-0.354
Ethane, C_2H_6	-0.789
Ethylene, C_2H_4	-0.553
Helium, H_e	-0.059
n-Heptane, C_7H_{16}	-2.508
n-Hexane, C_6H_{12}	-2.175
cyclo-Hexane, C_6H_{12}	-1.915
Hydrogen, H_2	-0.117
Hydrogen Bromide, Hbr	-0.968
Hydrogen Chloride, HC1	-0.651
Hydrogen Fluoride, HF	-0.253
Hydrogen Iodide, HI	-1.403
Hydrogen Sulphide, C_2S	-0.751
Kryton, Kr	-0.853
Methane, CH_4	-0.512
Neon, Ne	-0.205
Nitric Oxide, NO	+44.2
Nitrogen, N_2	-0.358
Nitrogen Dioxide, NO_2	+28.7
n-Octane, C_8H_{18}	-2.840
Oxygen, O_2	+100.0
n-Pentane, C_5H_{12}	-1.810
iso-Pentane, C_5H_{12}	-1.853
neo-Pentane, C_5H_{12}	-1.853
Propane, C_3H_8	-1.135
Propylene, C_3H_6	-0.903
Water, H_2O	-0.381
Xenon, Xe	-1.340

TABLE 3-3. OXYGEN EQUIVALENT OF COMMON GASES

EXAMPLE: ZERO-SUPPRESSED RANGE

Range 50% to 100% oxygen

At lower range-limit, i.e., 50% oxygen composition of sample is: 50% oxygen: 30% CO_2: 20% N_2.

From Table 3-4, the % oxygen equivalents are: O_2 + 100%, CO_2, -0.623%; N_2, -0.358%

% oxygen equivalent of mixture

$$\begin{aligned} &= 0.5 \times (+100) + 0.3 \times (-0.623) + 0.2 \times (-0.358) \\ &= +50.00 + (-0.187) + (-0.072) \\ &= +49.7415\%\ O_2 \end{aligned}$$

3.3.2 COMPUTING ADJUSTED SETTINGS FOR ZERO AND SPAN CONTROLS

During instrument calibration, adjusted values may be required in setting the ZERO and SPAN Controls, to correct for the magnetic susceptibility of the background gas. The quantities are defined as follows (see Table 3-3):

BGGst = Oxygen equivalent of background gas in standard gas
BGGs = Oxygen equivalent of background gas in sample
PO = Operating pressure

Use the following equation to compute the adjusted settings for the ZERO and SPAN Controls:

Adjusted % oxygen for standard gas =

$$\frac{[\text{true } \%\ O_2 \text{ of standard gas}]\,[100 + (BGGs - BGGst)] - 100\,[BGGs - BGGst]}{100}$$

Use the following equation to compute the adjusted settings for the ZERO and SPAN Controls, see equation below.

EXAMPLE

Background gas in sample is CO_2, oxygen equivalent = -0.623%.

Downscale standard gas is 100% N_2.

Upscale standard gas is air: 21% O_2, 79% N_2.

Background gas in downscale and upscale standard gases is N_2, oxygen equivalent = -0.358%.

With N_2 downscale standard gas flowing, ZERO control is adjusted so meter reads:

$$\frac{0\,[100 + (-0.623 - (-0.358)] - 100\,[-0.623 - (-0.358)]}{100} = 0.265\ \%\ O_2$$

With air flowing SPAN control is adjusted so meter reads:

$$\frac{21\ (100 - 0.265) - 100\ (-0.265)}{100} = 21.209\ \%\ \ O_2$$

In two limiting cases, the general equation reduced to simpler forms.

1. If the upscale standard gas is 100% oxygen, the adjusted oxygen value for setting the SPAN Control is the same as the true value, i.e., 100% *oxygen*.
2. If the downscale standard is an oxygen-free gas, the adjusted value for setting the ZERO Control = BGGst - BGGs. (If the oxygen-free zero gas is more diamagnetic than the background gas in the sample, this difference is negative. The meter scale is not calibrated with negative values; however, a negative value may be set on the recorder if provided with below-zero capability.)

NOTES

4

OPERATION

4.1 ROUTINE OPERATION

After the calibration procedure of Section 3.2, admit sample gas to the analyzer at the same pressure and the same flow rates as used for the downscale and upscale gases. The instrument will now continuously indicate the oxygen content of the sample gas.

If desired, the % RANGE Switch may be moved to a setting of lower sensitivity, i.e., of wider span, than was used during calibration.

At this time an adjustment of instrument response time via R20 (Figure 3-1) may be desirable to obtain the optimum compromise between response speed and noise.

4.2 EFFECT OF BAROMETRIC PRESSURE CHANGES ON INSTRUMENT READOUT

If the analyzer exhaust port is vented through a suitable absolute back-pressure regulator barometric pressure changes do not affect the percent oxygen readout. However, if the analyzer exhaust port is vented directly to the atmosphere, any change in barometric pressure after instrument standardization will result in a directly proportional change in the indicated percentage of oxygen. This effect may be compensated in various ways. If desired, correction may be made by the following equation:

Where:

Pst = Operating pressure during standardization

Pan = Operating pressure during sample analysis

EXAMPLE (U.S. Units)

Pst = 760 mm Hg

Pan = 740 mm Hg

Indicated % O_2 = 40%

True % O_2 = 40% = 41.1% O_2

EXAMPLE (S.I. Units)

Pst = 101 kPa

Pan = 98.2 kPa

Indicated % O_2 = 40%

True % O_2 = 101/98.2 x 40% = 41.1% O_2

4.3 CALIBRATION FREQUENCY

The appropriate calibration interval will depend on the accuracy required in the particular application, and is best determined by keeping a calibration log. If the analyzer exhaust port is vented directly to the atmosphere, the greatest source of error is normally the variation in barometric pressure. If desired, effects of barometric pressure variation can be minimized by calibrating immediately before taking readings, for example, at the beginning of each shift.

5

INSTRUMENT THEORY

5.1 PRINCIPLES OF OPERATION

Compared with other gases, oxygen is strongly paramagnetic. Other common gases, with only a few exceptions, are weakly diamagnetic. The paramagnetism of oxygen may be regarded as the capability of an oxygen molecule to become a temporary magnet when placed in a magnetic field, analogous to the magnetization of a piece of soft iron. Diamagnetic gases are analogous to non-magnetic substances.

With the Model 755, the volume magnetic susceptibility of the flowing gas sample is sensed in the detector/magnet assembly. As shown in the functional diagram of Figure 5-1, a dumbbell-shaped nitrogen-filled hollow glass test body is suspended on a platinum/nickel alloy ribbon in a non-uniform magnetic field. Because of the "magnetic buoyancy" effect, the spheres of the test body are subjected to displacement forces, resulting in a displacement torque that ies proportional to the volume magnetic susceptibility of the gas surrounding the test body.

Measurement is accomplished by a null-balance system, where the displacement torque is opposed by an equal, but opposite, restorative torque. The restorative torque is due to electromagnetic forces on the spheres, resulting from a feedback current routed through a titanium wire conductor wound lengthwise around the dumbbell. In effect, each sphere is wound with a one-turn circular loop. The current required to restore the test body to null position is directly proportional to the original displacement torque, and is a linear function of the volume magnetic susceptibility of the sample gas.

The restoring current is automatically maintained at the correct level by an electro-optical feedback system. A beam of light from the source lamp is reflected off the square mirror attached to the test body, and onto the dual photocell. The output current from this combination is equal to the difference between the signals developed by the two halves of the photocell. This difference, which constitutes the error signal, is applied to the input of an amplifier circuit that provides the restoring current. When the test body is in null position, both halves of the photocell are equally illuminated; the error signal is zero; and the amplifier output remains constant. As soon as the test body begins to rotate, however, the amounts of light become unequal. resulting in application of an error signal to the input of the amplifier circuit. The resultant amplifier output signal is routed through the current loop, thus creating the electromagnetic forces required to restore the test body to null position. Additionally the output from the amplifier is conditioned as required to drive the meter, and recorder if used. The electronic circuitry involved is described briefly in Section 5.3 and in greater detail in Section Six.

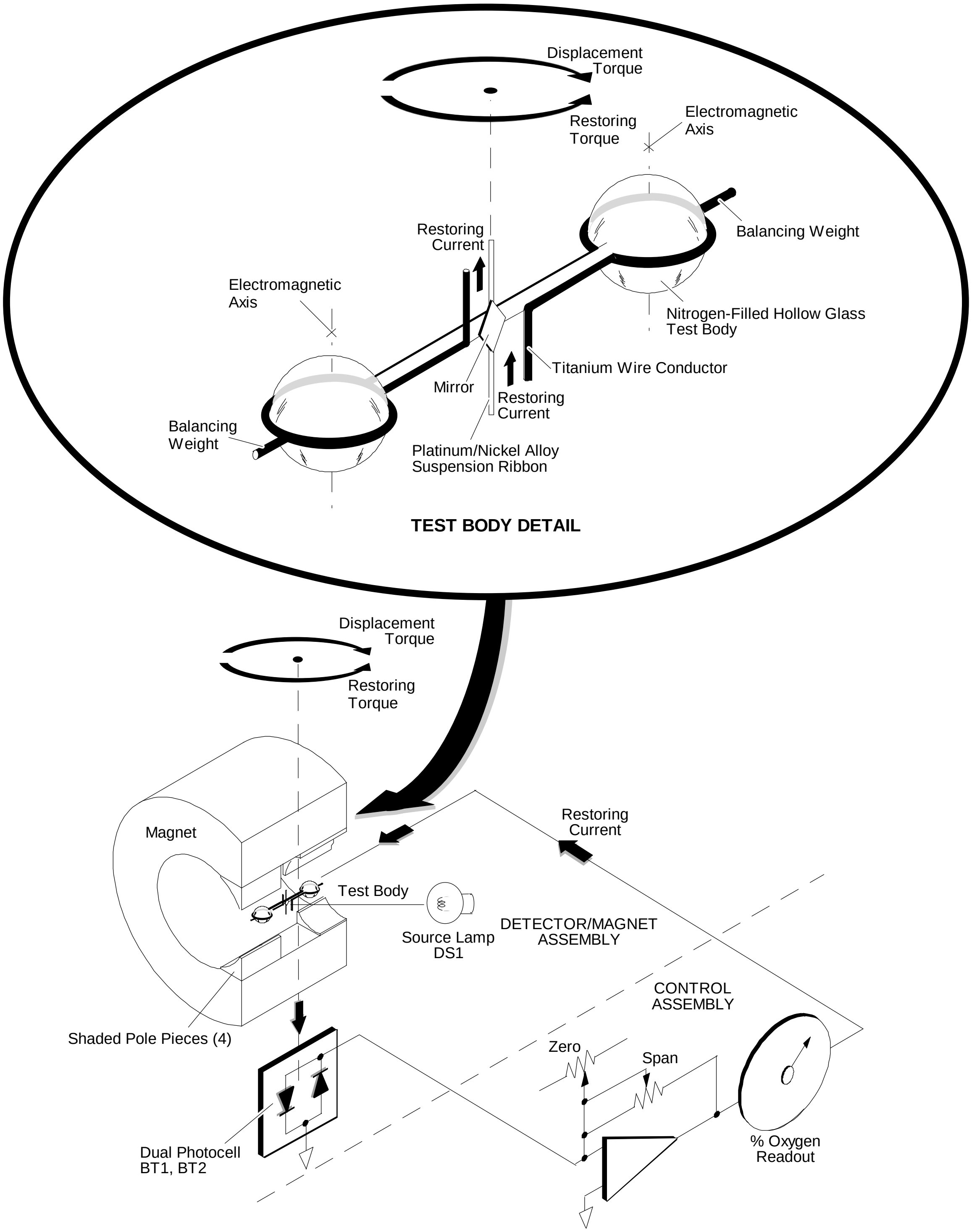


FIGURE 5-1. FUNCTIONAL DIAGRAM OF MODEL 755 PARAMAGNETIC OXYGEN MEASUREMENT SYSTEM

5.1.1 MAGNETIC DISPLACEMENT FORCE

Because the magnetic forces on the spherical ends of the test body are the basis of the oxygen measurement, it is worthwhile to consider the force acting on one of these spheres alone and to disregard, for the present, the remainder of the detector. A small sphere suspended in a strong non-uniform magnetic field. Figure 5-2, is subjected to a force proportional to the difference between the magnetic susceptibility of this sphere and that of the surrounding gas. Magnitude of the force is expressed by the following simplified equation:

$$Fk = c\ (k - ko)$$

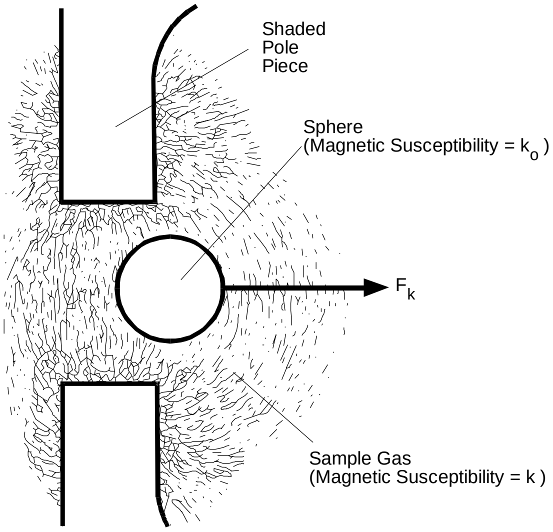
Where:

c = A function of the magnetic field strength and gradient

k = Magnetic susceptibility of the surrounding gas

ko = Magnetic susceptibility of the sphere

The forces exerted on two spheres of the test body are thus a measure of the magnetic susceptibility of the sample, and therefore of its oxygen content.



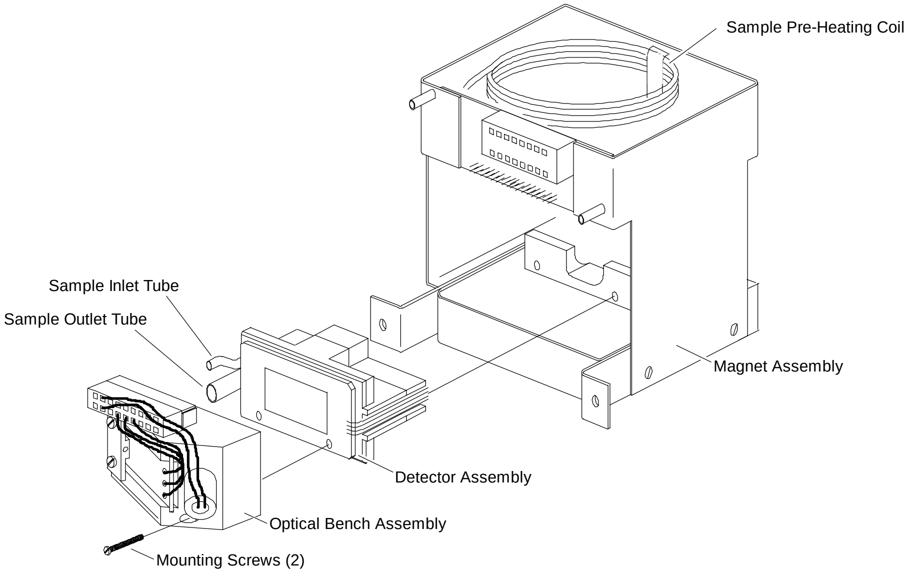
Note:
As percentage of oxygen in sample gas increases, displacement force (F_k) increases.

FIGURE 5-2. SPHERICAL BODY IN NON-UNIFORM MAGNETIC FIELD

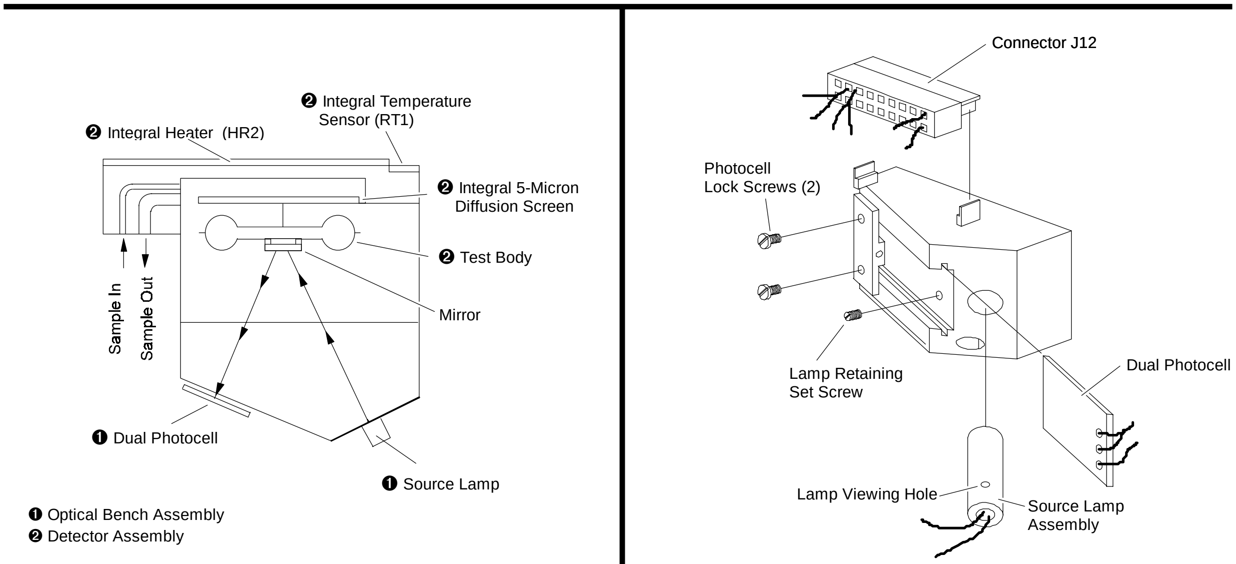
5.1.2 PHYSICAL CONFIGURATION OF DETECTOR/MAGNET ASSEMBLY

As shown in the exploded view of Figure 5-3A, the detector/magnet assembly consists of three major subassemblies: the magnet assembly, the detector assembly, and the optical bench assembly.

The magnet assembly includes a sample preheating coil. It is connected into the sample line, upstream from the detector, and is heated to approximately the same temperature as the detector assembly.



A. Exploded View of Detector/Magnet Assembly



B. Sectional Top View of Optical Bench and Detector Assemblies

C. Exploded View of Optical Bench Assembly

FIGURE 5-3. DETECTOR/MAGNET ASSEMBLY

For convenience in servicing, the detector and the optical bench are self-aligning assemblies that utilize slip-on sample connections and plug-in electrical connection.

Within the detector assembly, Figure 5-3B, the incoming preheated sample passes through an integral 5-micron diffusion screen. It protects the test body by preventing entry of particulate matter and/or entrained liquid mist. Additionally the screen isolates the test body from flow effects, ensuring that instrument readout is relatively independent of flow rate within the optimum range of 200 to 300 cc/min.

At the rear of the detector are an integral temperature sensor (RTI) and an integral heater (HR2). Another heater (HR1) is attached to the magnet. Sensor RTI provides the input signal to the detector temperature control section of the case circuit board assembly, Section 5.3.3. This section controls application of electrical power to both HR1 and HR2.

On the optical bench assembly, see Figure 5-3C, the source lamp and the photocell plate are externally accessible, permitting convenient replacement.

5.2 VARIABLES INFLUENCING PARAMAGNETIC OXYGEN MEASUREMENTS

Variables that influence paramagnetic oxygen measurements include: Operating pressure, Section 5.2.1, sample temperature, Section 5.2.2; interfering sample components, Section 5.2.3; and vibration, Section 5.2.4

5.2.1 PRESSURE EFFECTS

Although normally calibrated for readout in percent oxygen, the Model 755 actually responds to oxygen partial pressure. The partial pressure of the oxygen component in a gas mixture is proportional to the total pressure of the mixture. Thus readout is affected by pressure variations. For instance assume that an instrument is calibrated for correct readout with a standard gas containing 5% oxygen, admitted at the normal sea-level atmospheric pressure of 14.7 psia (101.3 kPa). If the operating pressure now drops to one-half the original value, i.e., to 7.35 psia (50.65 kPa), and the calibration controls are left at the previously established settings, the meter reading for the standard gas will drop to 2.5%.

It is therefore necessary to calibrate the instrument at the same pressure that will be used during subsequent operation, and to maintain this pressure during operation.

Typically the sample gas is supplied to the analyzer inlet at slightly above ambient pressure, and is discharged to ambient pressure from the analyzer outlet. However with most applications involving zero-suppressed ranges, and some applications of zero-based ranges, it is necessary to insert an absolute back-pressure regulator into the exhaust line to prevent the readout error that would otherwise result from fluctuations in exhaust pressure. The regulator must be mounted in a temperature-controlled housing, see Section 2.6.3.

CAUTION: PRESSURE LIMITS

Do not subject the sensing unit to an absolute pressure of less than 600 mm Hg (88.1 kPa)

Operation at negative gauge pressure is not normally recommended. but is used in certain special applications, see Section 2.6.4.

5.2.2 TEMPERATURE EFFECTS

Magnetic susceptibilities and partial pressures of gases vary with temperature. In the Model 755, temperature-induced readout error is avoided by control of temperatures in the following areas:

1. Interior of the analyzer is maintained at 140°F (60°C) by an electrically controlled heater and associated fan.
2. Immediately downstream from the inlet port, prior to entry into the detector, the sample is preheated by passage through a coil maintained at approximately the same temperature as the detector, see Figure 5-3A.
3. The detector is maintained at a controlled temperature of 150°F (66°C).

5.2.3 INTERFERENTS

Instrument response to most non-oxygen sample components is comparatively slight, but is not in all cases negligible. During initial installation of an instrument in a given application, effects of the background gas should be calculated to determine if correction is required, refer to Section 3.3.

5.2.4 VIBRATION EFFECTS

INSTRUMENT DESIGN

To minimize vibration effects, the detector/magnet assembly is contained in a shock-mounted compartment (Figure 1-2).

INSTALLATION

Use reasonable precautions to avoid excessive vibration. In making electrical connections, do not allow any cable to touch the shock-mounted detector assembly or the associated internal sample inlet and outlet tubing. This precaution ensures against possible transmission of mechanical vibration through the cable to the detector, which could cause noisy readout.

ELECTRONIC RESPONSE TIME

If readout is noisy despite observance of the precautions mentioned, obtain slower electronic response by counter-clockwise adjustment of R20, Figure 3-1.

5.3 ELECTRONIC CIRCUITRY

Electronic circuitry is shown in the circuit-door schematic diagram, DWG 632363, and is described briefly in the following sections. For detailed circuit analysis refer to Section Six. Schematic diagrams and other engineering drawings are placed at the back of this manual.

5.3.1 DETECTOR/MAGNET ASSEMBLY

A cross-sectional view of the optical bench and detector assemblies is shown in Figure 5-3B. Source lamp DS1 powered by a supply section within the case circuit board assembly, see Section 5.3.3, directs a light beam onto the mirror attached to the test body. The mirror reflects the beam onto dual photocell BTI, BT2. The difference between the signals developed by the two halves of the photocell constitutes the error signal supplied to the input of amplifier AR1 on the control board assembly. Amplifier AR1 drives AR2, which in turn supplies the restoring current to the titanium wire loop on the test body, refer to Section 5.1.

ELEMENTS OF DETECTOR TEMPERATURE CONTROL CIRCUIT

Detector temperature is sensed by thermistor RT1, an integral part of the detector assembly, see Figure 5-3B. The thermistor provides the input signal to the detector temperature control section of the case circuit board assembly. The output from this section is applied to two heaters within the detector/magnet assembly: HR1. mounted on the top of the magnet, and HR2, mounted permanently on the rear of the detector assembly.

5.3.2 CONTROL BOARD AND ASSOCIATED CIRCUITRY

The control board contains signal-conditioning and control circuitry. The board is mounted on the inside of the analyzer door, as shown in Figure 1-2.

The control board contains the following:

INPUT AMPLIFIER AR1

This amplifier receives the error signal from the dual photocell of the detector assembly and, in turn, drives amplifier AR2.

AMPLIFIER AR2 AND ASSOCIATED ZERO AND SPAN CIRCUITRY

Amplifier AR2 supplies the restoring current to the titanium wire loop of the test body within the detector assembly. Front-panel ZERO Control R10 applies an adjustable zero-biasing signal to the input of AR2, to permit establishing a downscale calibration point on the meter scale or recorder chart. With downscale standard gas flowing through the analyzer, the ZERO control is adjusted for the appropriate reading.

If the analyzer is to incorporate a zero-suppressed range option, the required zero offset is obtained by insertion of the zero suppression resistor module into receptacle J6. This module may be inserted either during factory assembly or in subsequent field installation of a range conversion kit.

Front-panel SPAN Control R4 provides continuously variable adjustment of closed-loop gain for AR2, to permit establishing an upscale calibration point on the meter scale or recorder chart. With upscale standard gas flowing through the analyzer. the SPAN control is adjusted for the appropriate reading.

AMPLIFIER AR3 AND ASSOCIATED RANGE CIRCUITRY

During factory assembly, or in subsequent field installation of a range conversion kit, the analyzer is provided with the desired range option by inserting the appropriate range resistor module into receptacle J3. In subsequent operation, the desired operating range is selected with front-panel % RANGE switch SW1, which determines the feedback resistance for AR3.

OUTPUT STAGE

Amplifier AR4 and Transistor Ql. The signal from range amplifier QR3 is routed through phase lead adjust R20 to an output stage consisting of AR4 and Ql.

Potentiometer R20 provides a continuously variable adjustment of 5 to 25 seconds for the electronic response time (90% of fullscale), and is factory-set for 20 seconds.

The output from Ql is routed to the following:

1. Output resistor network, Item 5.
2. Current output receptacle Jl. This connector accepts any of the three optional plug-in current-output boards.
3. Alarm output receptacle J2. This connector accepts the optional dual-alarm amplifier board.

OUTPUT RESISTOR NETWORK

The output signal from Ql is routed to ground via a voltage divider. A selector plug associated with the voltage divider provides a selectable output of 0 to 10 mV, 0 to 100 mV, 0 to 1 V, or 9 to 5 VDC to drive a voltage recorder. Potentiometer R38 permits adjusting the meter to agree with the recorder.

5.3.3 CASE BOARD ASSEMBLY

The case circuit board contains power-supply and temperature-control circuitry. The board is mounted within the analyzer case, near the top, as shown in Figure 1-2.

As shown in DWG 632363, the various circuits operate on main power transformer T1. During instrument assembly, the two primary windings of T1 are factory-connected for operation on either 120 VAC or 240 VAC, as noted on the name-rating plate.

The case board contains the following:

SOURCE LAMP POWER SUPPLY SECTION

This circuit provides a regulated output of 2.30 VDC to operate incandescent source lamp DS1 within the optical bench assembly. One secondary of main power transformer T1 drives a fullwave rectifier consisting of CR7 and CR8. The output of DS1 is held constant by a voltage regulator circuit utilizing AR7, Q4, and Q5.

THE ±15 V POWER SUPPLY SECTION

This section provides DC voltage required for various amplifiers and other circuits.

Fullwave rectifier bridge CR5 provides both positive and negative outputs. Each is routed through an associated series-type integrated-circuit, voltage-regulator, providing regulated outputs of +15V and -15V.

DETECTOR TEMPERATURE CONTROL SECTION

This section maintains the detector at a controlled temperature of 150°F (66°C). Temperature is sensed by RT1, a resistance element permanently attached to the detector assembly.

The signal from the sensor is applied to amplifier AR6, which drives transistors Q2 and Q3, thus controlling application of DC power from full-wave rectifier bridge CR6 to two heaters within the detector/magnet assembly: HRI, mounted on the top of the magnet; and HR2, permanently mounted on the rear of the detector assembly.

CASE TEMPERATURE CONTROL SECTION

This section maintains the interior of the analyzer case at a controlled temperature of 140°F (60°C).

Temperature is sensed by a thermistor on the control board assembly (i.e., case door circuit board), adjacent to critical electronic components including the range and zero-suppression resistor modules.

The circuit provides an on-off control of heater element HR3 via TRIAC element Q7. Heater HR3 is a part of the heater/fan assembly.

5.3.4 ISOLATED CURRENT OUTPUT BOARD (OPTIONAL)

An isolated current output is obtainable the optional current output board. The board mounts onto the control board, see Figure 1-2.

5.3.5 ALARM OPTION

The alarm option provides two sets of relay contacts for actuation of customer-supplied alarm and/or process-control devices. The alarm has two single-pole, double-throw relays, one each for the ALARM 1 and ALARM 2 contacts. Alarm output connections are on the terminal board shown in Figure 1-2.

NOTES

6 CIRCUIT ANALYSIS

The electronic circuitry of the Model 755 Oxygen Analyzer consists of the following:

- Case heater circuit
- Detector heater circuit
- ±15 VAC power supply
- Voltage regulating circuit for a stable light source
- Detector circuit with a first-stage amplifier to provide a feedback current for mechanical feedback to the detector and a scaling amplifier circuit to give an output change of 0 to +7.5 V for a 0 to 100% change of the operating span.

6.1 POWER SUPPLY ±15 VDC

The components of the ±VDC power supply circuit are located in the lower the left-hand corner of the case circuit board. 19 VAC should be measured with respect to ground at CR5 (WO4). A +15 VDC should be measured at C27 (+) lead and -15 VDC at the C28 (-) lead. If the specified voltage measurements are obtained, the power supply is working correctly, see DWG 617186.

6.2 CASE HEATER CONTROL CIRCUIT

The case heater control circuit utilizes four voltage-comparators (LM339 quad comparator). An understanding of how one of these comparators functions is necessary before any circuit analysis can be attempted.

In Figure 6-1, comparators 1 and 2 are depicted having a comparator within an overall comparator symbol. Also within this symbol, the base of an NPN transistor is connected to the output of the comparator. A -15 VDC is supplied to the emitter. The collector is illustrated as the overall output for the comparator package.

When the noninverting terminal of comparator 2 is more positive than the inverting terminal, the transistor does not conduct and the collector of the transistor or comparator output is at whatever potential is the present on the collector.

When the noninverting terminal of comparator 2 is less positive (more negative) than the inverting terminal, the transistor conducts and the output of the comparator is -5V. This value is the output of the OR circuit.

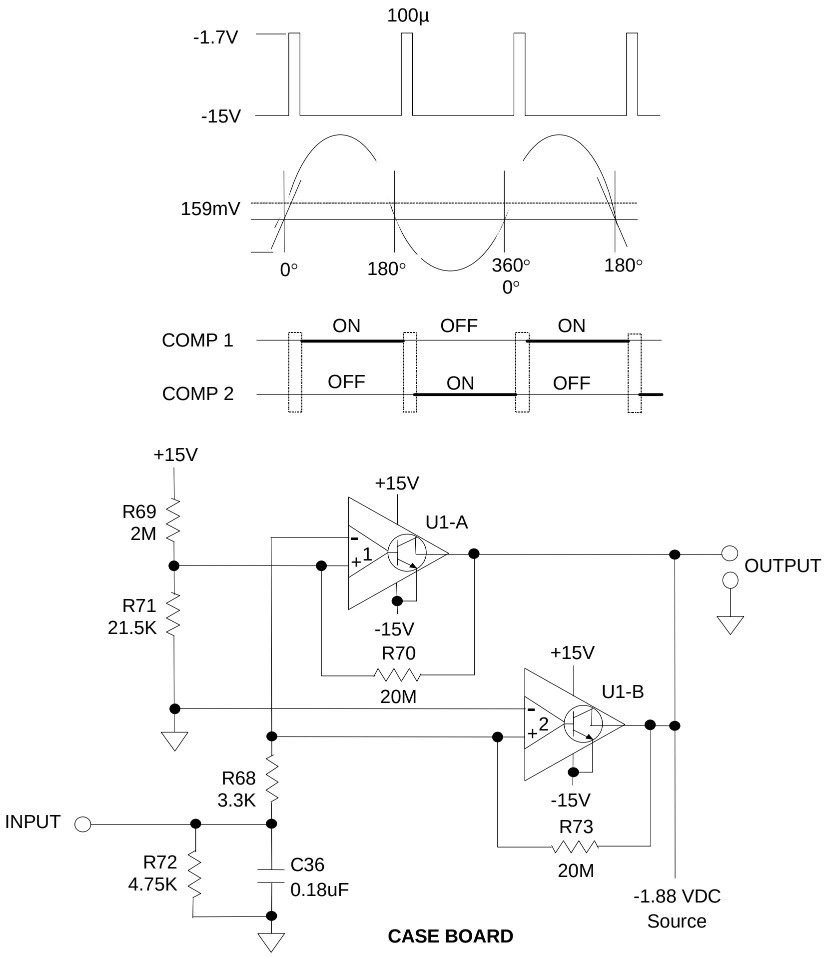


FIGURE 6-1. TWO-COMPARATOR OR CIRCUIT

Comparator 2 is biased at 0 volts on the inverting terminal. Comparator 1 is biased at about 159 mV on the noninverting terminal. There is a slight amount of positive feedback or hysteresis built into each comparator circuit for stability or positive action. This is achieved by the 20 M resistances, R70 and R73.

An approximate 8 V peak-to-peak AC signal is applied to comparators 1 and 2. As the signal starts going positive, comparator 2 transistor ceases conducting and comparator 1 transistor is off. When the signal exceeds the +159 mV on the noninverting terminal, it turns on comparator 1 and the output is -15 V. Comparator 1 stays on until the signal drops below +159 mV, at which time the output will be the value on the OR bus. As the AC signal goes negative with respect to ground, the transistor of comparator 2 conducts and the output is again -15 V. The output remains at -15 VDC until the incoming signal crosses zero value and the positive signal causes the comparator 2 transistor to cease to conduct.

Summing the effects of the two comparators in the OR circuit results in no output from the comparators for about 4° of the sinewave, 2° after the signal goes positive (0 to 2°) and 2° before the positive signal reaches 180° (178° to 180°).

During the period that neither comparator is conducting, the value on the OR bus is the potential from the temperature-sensing bridge plus the effect of the ramp generator, probably -188 ±0.03 V.

The on-off effect of the comparators to the OR circuit results in application of a positive-going pulse (from -15 V to -1.89 V) to the temperature bridge at the rate of 120 pulses per second.

Capacitor C36 is added to the input circuit to delay the incoming AC signal so that the pulses will occur at or just after the line frequency crossover point.

Circuits for a ramp generator and a temperature-sensing bridge are part of the case heater control circuit of Figures 6-2 and 6-3.

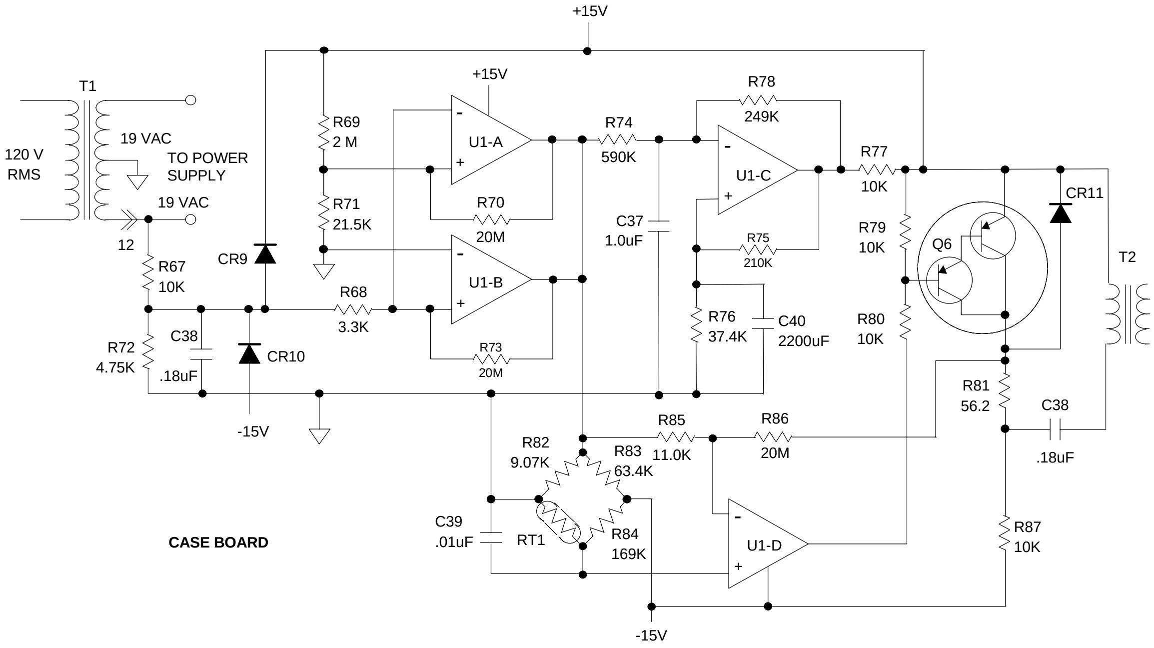


FIGURE 6-2. CASE HEATER CONTROL CIRCUIT

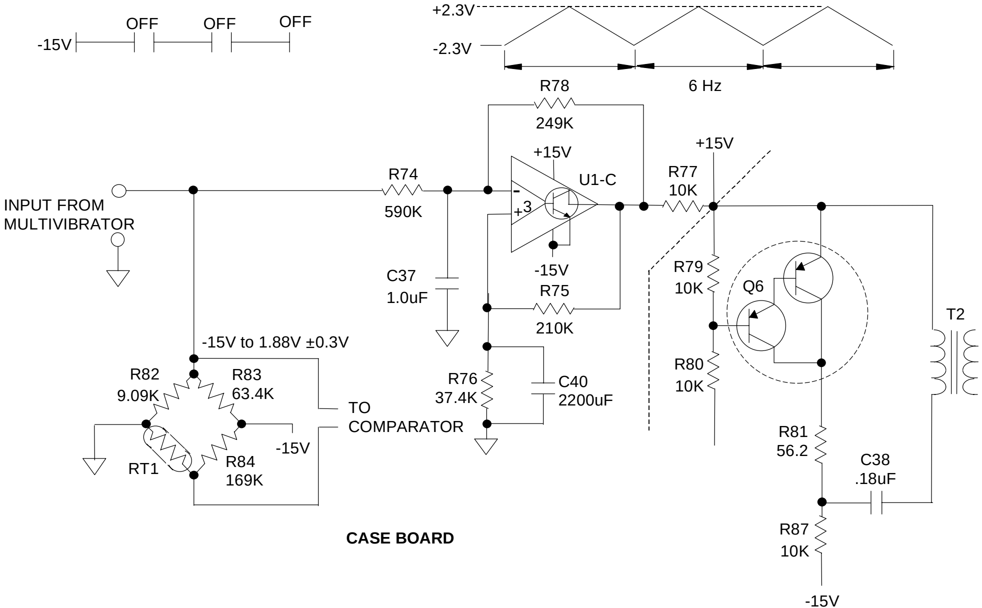


FIGURE 6-3. RAMP GENERATOR

On initial application of power to comparator of Figure 6-2, no potential exists on the inverting terminal because no charge exists on capacitor, C37. If the transistor of comparator 3 does not conduct, +15 V is at the output terminal. With +15 V at the output, the potential on the noninverting terminals will be about ±2.3V because of the resistance divider R75, R76. Capacitor C37 will now start to charge positively through R78. When the positive potential across C37 and at the inverting terminal of comparator 3 exceeds the potential on the noninverting terminals, the transistor conducts. The output is -15 V. A full 30 V drop appears across R77. The potential on the noninverting terminal will now be about -2.3 V. Now C37 will discharge through R78 until its potential exceeds that on the noninverting terminal. At that time. comparator 3 will switch polarity and start charging C37 again. The result is that the potential across C37 will vary almost linearly with time and form a ramp signal of about 6 Hz.

As the potential across C37 increases and decreases linearly, it affects the potential at the top of the bridge circuit between R82 and R83 through R74. Because of the ramp action charging and discharging C37, the potential between R82 and R83 varies approximately from -1.85 V to -1.92 VDC.

The temperature-sensing device, RT1, in the bridge circuit is a thermistor. The bridge is designed to control the temperature in the case at 135°F (57°C). When the temperature is 135°F (57°C), the resistance of the thermistor RT1 will be at its lowest and the potential at the junction of RT1 and R84 should be the same as the junction of R82 and R83. Comparator 4 in Figure 6-4 does not allow pulses from the OR circuit (comparators 1 and 2), to operate Q6 or TRIAC Q7 in the case heater, see Figure 6-5.

Theoretically at 135°F (57°C) the potential at the junction of RT1 and R84 is -1.85 VDC. This is equivalent to a resistance of 21.2 K. By substituting a decade box for the thermistor and placing 20.2 K into the bridge, the heater should be off. With 22.7 K, the heater should be full on.

Since the potential at the junction of R82 and R83 can vary between 1.85 V and 1.92 V according to the 6 Hz ramp, and the potential at the junction of RT1 and R84 may vary around or within these limits, depending on temperature, the error signal to comparator 4 may vary from 0 mV to some absolute value. The polarity of the error signal will depend on the deviation from the desired temperature and the ramp value at the function of R82 and R83.

The input from the OR circuit comparator, Figure 6-1, is either -15 VDC or the ramp effect on the bridge. When -15V, the junction of R82 and R83 is also this value. The error signal into comparator 4 is negatively large to the inverting terminal. Comparator 4 output transistor does not conduct. The base of Q6 is positive. Therefore Q6 does not conduct and a charge builds up on capacitor C38.

The input from the OR comparators 1 and 2 form multivibrator circuit, pulses 120 times a second. For about 100 microseconds the junction of R82 and R83 is some value between -1.85 V and -1.92 V, depending on the ramp generator. For this brief period of time (one pulse), comparator 4 compares the potential of junction R82, R83 with junction RT1, R84 of the bridge circuit. If the temperature at RT1 is low, the potential at the noninverting terminal of comparator 4 is more negative and the output is -15 V.

The base of Q6 is zero. because of the voltage drops across R79 and R80, therefore Q6 conducts. Energy stored in C38, flows through Q6 as current and capacitor C38 discharges to zero potential. No current flows through the primary winding of transformer T2. At the end of the 100 microsecond pulse, the NPN transistor in the output of Comparator 4 ceases to conduct. so the signal on the base of Q6 is +15 V. Q6 ceases to conduct. C38 starts to charge. driving electrons (current) through the primary of T2. This induces a pulse into the secondary of T2 and to the gate of TRIAC Q7, turning it on. At the beginning of the next 100 microsecond pulse, comparator 4 output is again -15 V, with zero volts on the base of Q6. Q6 again conducts, discharging C38. At the end of the 100 microsecond pulse, Q6 ceases to conduct and C38 charges and a pulse appears at the gate of TRIAC Q7, turning it on again. The charging time for C38 is about one-half a time constant (C38, R87), and ten time constants (R81, C38) are available for discharging C38.

The above action is repeated as long as the temperature is low, causing an error between R82, R83 junction, and RT1, R84 junction. As the temperature approaches the desired case temperature of 135°F (57°C), differences between these two junctions will exist for only part of each ramp and the number of pulses operating Q7 will be proportional to the amount of error sensed by the 6 Hz ramp.

The pulses arrive at Q7 just as the supply AC line voltage is passing the zero-volt crossover point. The purpose of C36 (grid location F-7, DWG 617186), is to delay the timing pulse, relative to line frequency, so that a pulse arrives at the gate of TRIAC Q7 as the line potential just passes the zero-volt crossover point (0 and 180 degrees of line phase).

Varistor RVI is a temperature-sensitive resistance device. When case temperature is low, such as ambient, the value of RVI is low. Applying power at that temperature might cause a current surge to damage TRIAC Q7. RVI with its low initial value of resistance acts as a bypass, and most of the current is shunted through it. As the temperature increases and approaches the desired case temperature, the resistance of RVI increases to a large value. This limits the current through it and gives fine control of the heater to TRIAC Q7 and the temperature-sensing circuit.

6.3 DETECTOR HEATER CONTROL CIRCUIT

Figure 6-4 is a simplified heater control circuit drawing for the detector. Heaters 1 and 2 are actually connected in parallel and have a combined resistance of about 17 ohm.

The thermistor resistance (RT1) in the resistance bridge varies inversely with temperature. The bridge is designed to maintain the temperature of the detector at 150°F (65.5°C).

The junction point between R55 and R56 is maintained at a specific voltage since these resistances maintain a definite ratio. The thermistor resistance is 149 K at 150°F (65.5°C) and increases rapidly as the temperature decreases. R59 in this bridge circuit represents the set-point value for temperature. Suppose that, at temperature, resistance of the bridge (R55, R56, R59, and RT1) equals 149 K.

If the temperature goes down, RT1 increases in resistance and causes the junction of RT1 and R59 to go positive in voltage value. Since R55 and R56 are of equal resistance, their junction is at zero volts. Therefore terminal 3 of AR6 is more positive than terminal 2 and the base of Q2 is positive. Q2 conducts, allowing alternating current to flow through heaters 1 and 2. The voltage drop across the heaters. when completely cold, would be around 20 VAC and, when controlling, would be AC of very low amplitude.

As the temperature increases the resistance of RT1 decreases and the junction point between RT1 and R59 becomes less positive. Terminal 3 of AR6 becomes less positive with respect to Terminal 2. The output of AR causes Q2 and Q3 to conduct less. When terminal 3 equals Terminal 2, or is less than terminal 2, the output of AR6 is zero or less. Q2 and Q3 do not conduct and the heater would not be supplying heat energy to the detector.

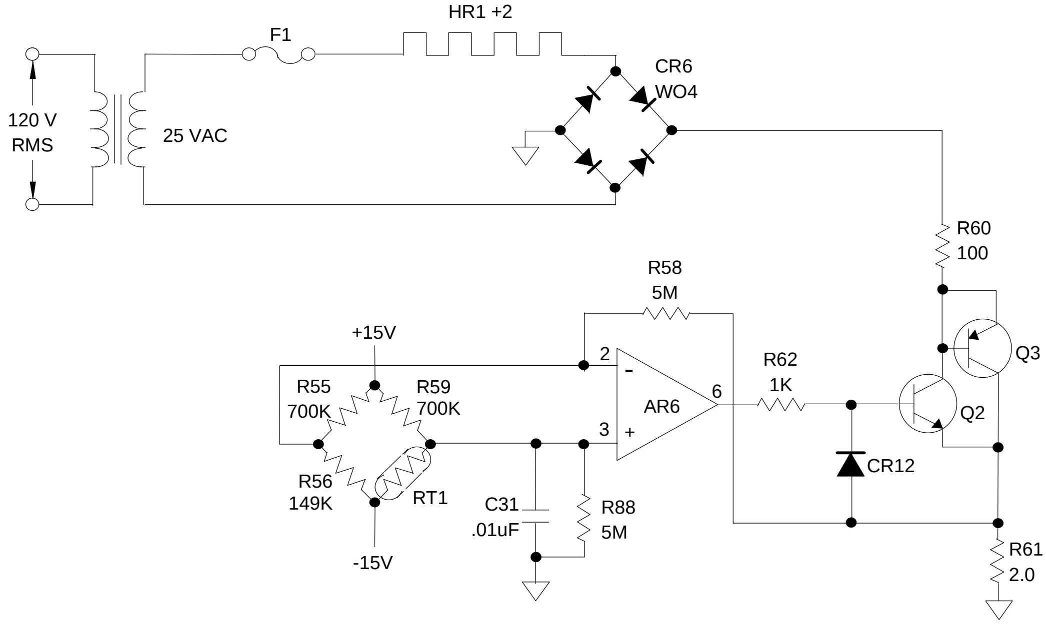


FIGURE 6-4. DETECTOR HEATER CONTROL CIRCUIT

6.4 DETECTOR LIGHT SOURCE CONTROL CIRCUIT

The detector light source control circuit maintains the light output from the bulb (DS1) as uniform as possible, regardless of voltage fluctuations or aging of the bulb, see Figure 6-5

The power source for the light bulb is a center-tapped secondary of transformer T1. This AC voltage is rectified by CR7 and CR8, and filtered (C32), presenting an approximate +8.5 V bus to the current-limiting Darlington configuration of Q4.Q4 controls the basic amount of current through DS1.

Amplifier U7 has a fixed value, approximately +2.2 VDC on Terminal 3. The output of U7 is positive, causing Q4 to conduct. As Q4 conducts, electrons flow from the center-tap of T1 to ground and from ground through DS1 for an input voltage to terminal 2 of U7, through R66 to develop a bias on the base of Q5, through Q4 to the +8.5 V bus, and back to the secondary. As Q5 conducts, some of the current going through DS1 is shunted from the main current path, and goes through Q5, which acts as a variable feedback resistance, goes to the positive output potential of U7.

As DS1 ages, its light emission decreases and its resistance increases. The current through DS1 tends to decrease, causing a decrease in the voltage drop across DS1 and the input potential to terminal 2 of U7. Now the output U7 will increase, causing Q4 to conduct more current through R66. As the potential across R66 increases, Q5 will conduct more current, causing a further increase in current flow through DS1. The net result is that the voltage across DS1 will remain uniform and the operation of Q4 and Q5 will adjust the gain of U7 to maintain the light emission from DS1 uniform for a long period of time.

Voltage fluctuations in the 120 VAC supply could cause some variation in the amount of current flowing through the bulb DS1, however the voltage drop across DS1 would cause U7 to adjust Q4 and the voltage drop across R66 to adjust Q5. The net result would still be uniform current flow through DSI and uniform light emission.

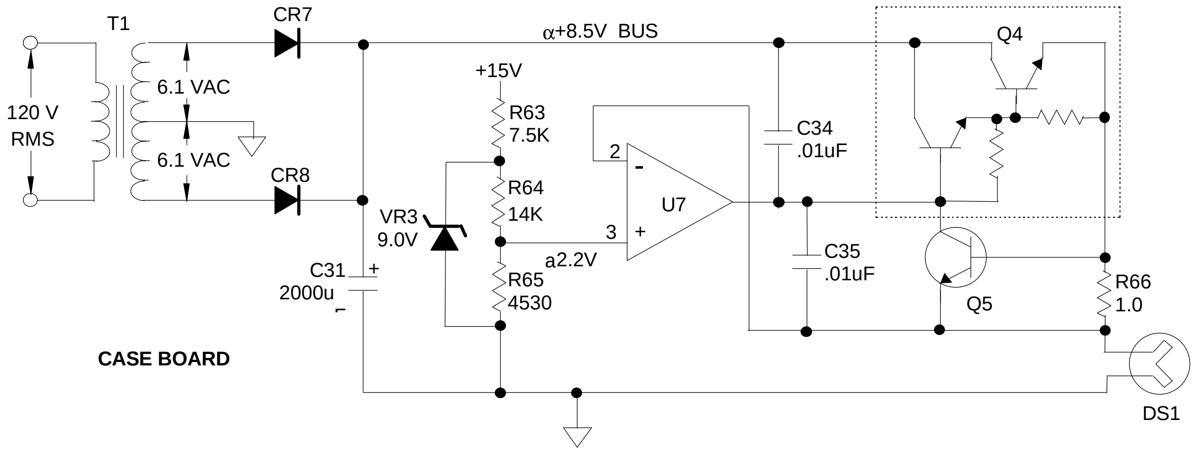


FIGURE 6-5. DETECTOR LIGHT SOURCE CONTROL CIRCUIT

6.5 DETECTOR WITH FIRST STAGE AMPLIFIER

The detector assembly consists of a test body suspended on a platinum wire and located in a nonuniform magnetic field, Figure 6-6.

The test body is constructed of two hollow glass spheres forming a dumbbell shape. They are filled and sealed with pure, dry nitrogen. Around the test body, a titanium wire is chemically etched in order to form a feedback loop that can create a counteracting magnetic force to the test body displacement caused by oxygen concentration in the test assembly magnetic field.

Attached to the center arm of the test body dumbbell is a diamond-shaped mirror. Attached to the mirror are two separate platinum wires in tension with the supports for the test body. The supports are isolated from ground and are electrically connected to the feedback loop and the electronics for that loop. The platinum wires form a fulcrum around which the test body pivots.

The detector operates in the following fashion. If the sample gas contains oxygen, it collects in the nonuniform magnetic field around the test body. Oxygen, because of its paramagnetic qualities, gathers along the magnetic lines of flux and forces the dumbbell of the test body to be forced out of the magnetic field.

A light source is focused on the test body mirror. As the test body moves out of the magnetic field. the mirror distributes light unevenly on two photocells (BT1 and BT2). The photocells create a current proportional to light. This current is converted to a plus-or-minus (±) voltage by U1 and U2, located on the connector board in the detector housing. This voltage is then presented to comparator U1. The output of U1 goes to U2. The output of U2 causes current to flow through the feedback loop attached to the dumbbell.

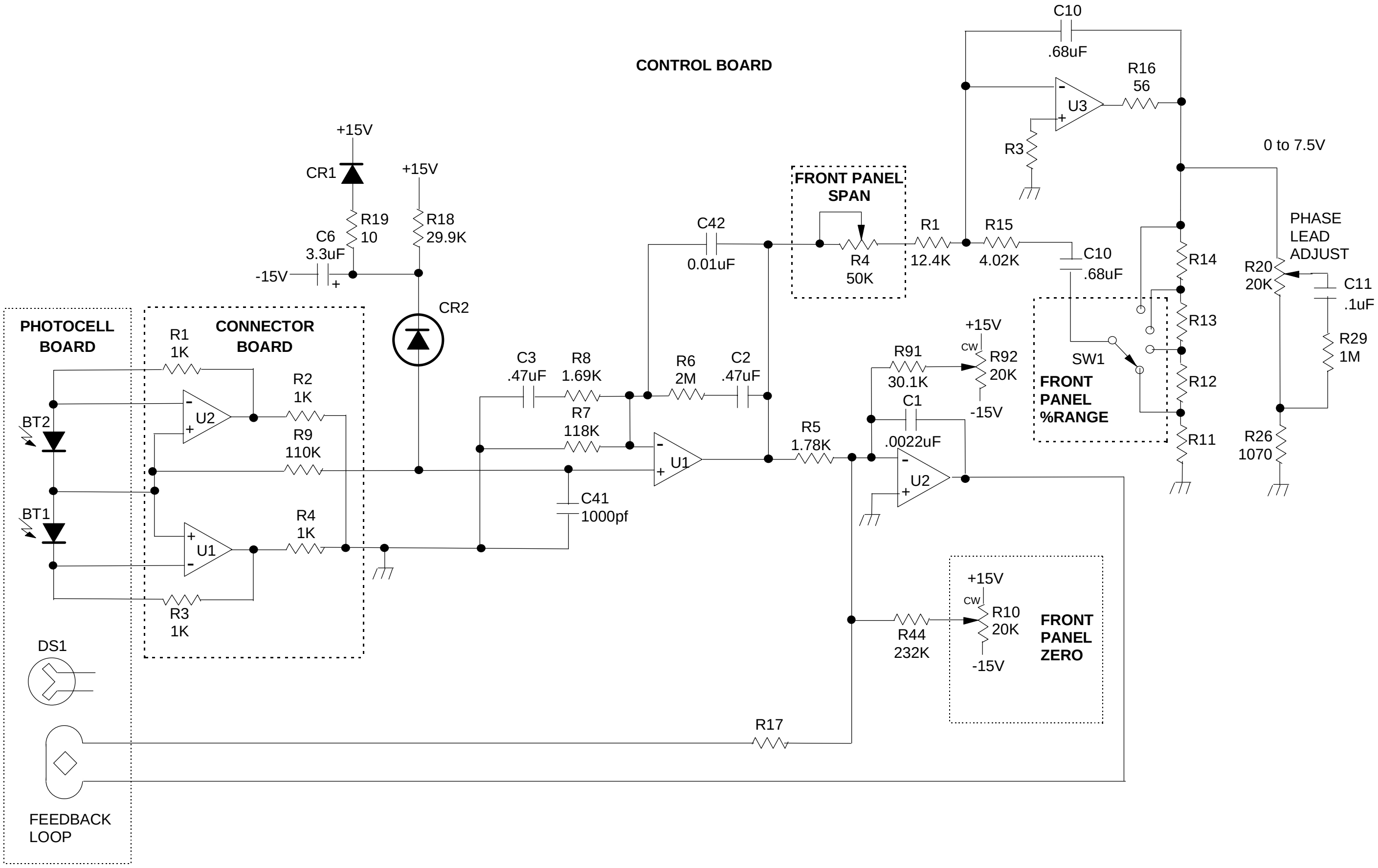


FIGURE 6-6. DETECTOR WITH FIRST STAGE AMPLIFIER

This feedback current creates an electro-magnetic field that attracts the dumbbell and mirror into the test assembly magnetic field until the mirror reflects light almost uniformly on each photocell. A current proportional to the oxygen concentration in the magnetic field of the test assembly has to be flowing through the feedback loop in order to maintain balance and provide a reading of the oxygen content of a sample.

Resistances R5, R17 and the resistance of the wire in the feedback loop determine the gain of amplifier U2. The mirror on the dumbbell is positioned by the amount of current in the feedback loop. The mirror reflects light from the source (DSI) to the photocells (BTI, BT2). This repositioning of the mirror is a form of mechanical feedback to the input of the amplifier U1. The net result is that the output of U1 could vary from 0 to -70 mV, or 0 to -7.0 V, depending on the range of the instrument. R8, C3 and R6, and C2 form damping circuits for the input amplifier UI and to smooth out noise that might be introduced by the measurement source.

R8, C3 and R6, and C2 form damping circuits for the input amplifier U1 and smooth out noise that might be introduced by the measurement source.

Diode CR2 is a low-leakage device. Its purpose in the circuit is to ensure that the dumbbell and mirror are positioned correctly with respect to the photocells on initial application of power.

If the dumbbell was out of position on start-up, the mirror might reflect light from the source onto one of the photocells. If the photocell output was positive, the current in the feedback loop would be in the wrong direction and its electromagnetic field would cause the dumbbell to be further repelled from the permanent magnetic field. The result would be error, not balance.

On application of AC power, capacitor C6 has no charge. The current will have to flow through R18. Initially the full 30-V drop (the difference between the +15 VDC and -15 VDC power) will appear across R18. The cathode of CR2 will be initially at -15 VDC. The anode of CR2 will be some value more positive than -15 VDC. CR2 will conduct. The input terminal of U1 will be negative and the current through the feedback loop around U2 will cause the dumbbell and mirror to be positioned correctly in the test body.

As the charge on C6 increases, the cathode of CR2 becomes more positive. When it exceeds that on the anode, CR2 ceases to conduct and isolates the +15 VDC and -15 VDC power supply from the input circuit.

If the measurement span is zero-based (0% to 10% for example), a simple voltage from front-panel ZERO potentiometer R10 may be added to the input of U2 to counteract any electrical offsets that may occur because of any imbalance in the detector and the photocells BTI and BT2. If the span is elevated (11% to 21% for example) or, in other words, the zero is suppressed, a zero suppression module is added to the circuitry around potentiometer R10. The modified potential from R10 is added to the input value to U2 to accomplish a balance at the lower limit of the particular measurement range.

Amplifier U3 receives the output of Ul (0 to -70 mV to 0 to -1.0 V) and amplifies this value. The output of U3 is always 0 to +7.5 V. This is accomplished by RANGE Switch SW1, which selects some portion of the output and supplies this value as feedback to the input of U3. Adjustment of the input resistance R4 gives span trim adjustment once the range has been selected by Range Switch SW1.

The output of U3 is picked off between R20 and R26 and brought into the final amplifier. The wiper of potentiometer R20 picks off a potential that helps give a little phase lead to the measurement circuit.

6.6 FINAL OUTPUT AMPLIFIER

The output of U3, in terms of 0 to +7.5 VDC for a zero to 100% change in measurement span, goes to the resistance divider circuit: R20 and R26, see Figure 6-7. The potential at the junction of R20, R26, and R29 for 100% of span would be about +0.465 V. This value is applied to the noninverting terminal of U4. The output of U4 causes Q1 to conduct. The voltage at the emitter of Q1 and its junction with R32 should vary from 0 to +5 VDC for a change of zero to 100% in measurement span. When the voltage at the emitter is +5 volts, the junction between R30 and R32 is ±0.465 V. This value is fed back through R31 to the inverting terminal of U4. This feedback value balances the input.

As the input measurement varies, the 0 to +7.5 V output of U3 varies proportionately. The junction of R20 and R26 changes between 0 and +0.465 V, causing the output at the emitter to vary from 0 to +5 V. This causes the junction between R30 and R32 to move between 0 and +0.465 V, to balance U4.

The wiper of R20 picks off a higher voltage value than that at the junction of R20 and R26. Under stable conditions, the difference between these two values appears across the capacitor C11, and the input to U4 is the value at the junction of R20 and R26. If the measurement increases, the wiper of R20 immediately picks off a higher value, which is transferred through C11 to U4, causing the output of Q1 to give a quicker indication of a change at the meter or recorder. Capacitor C11 will charge up to the new difference between the potential at the wiper of R20 and the junction R20, R26. The amount of phase lead will depend on the R29, C11 time constant and the potential difference during a change.

The +6.2 V zener diode (CR3), the +15VDC supply, and the 1.0K (R40) combine to limit the output supplied by U4 to the base of Ql to -0.6 V and +6.2 VDC.

Since the output of the final amplifier is 0 to +5 VDC, R38 is used as a trim potentiometer to set the correct amount of current (1 mA) through the output meter for fullscale deflection.

Jumper J7 is used to select the output range value for a voltage input recorder. If a current converter board or an alarm board is used, the output voltage value is supplied to each board as an input signal.

The 6.2 VDC determined by zener diode CR3 is also the reference supply for the alarm point adjustments on the alarm board.

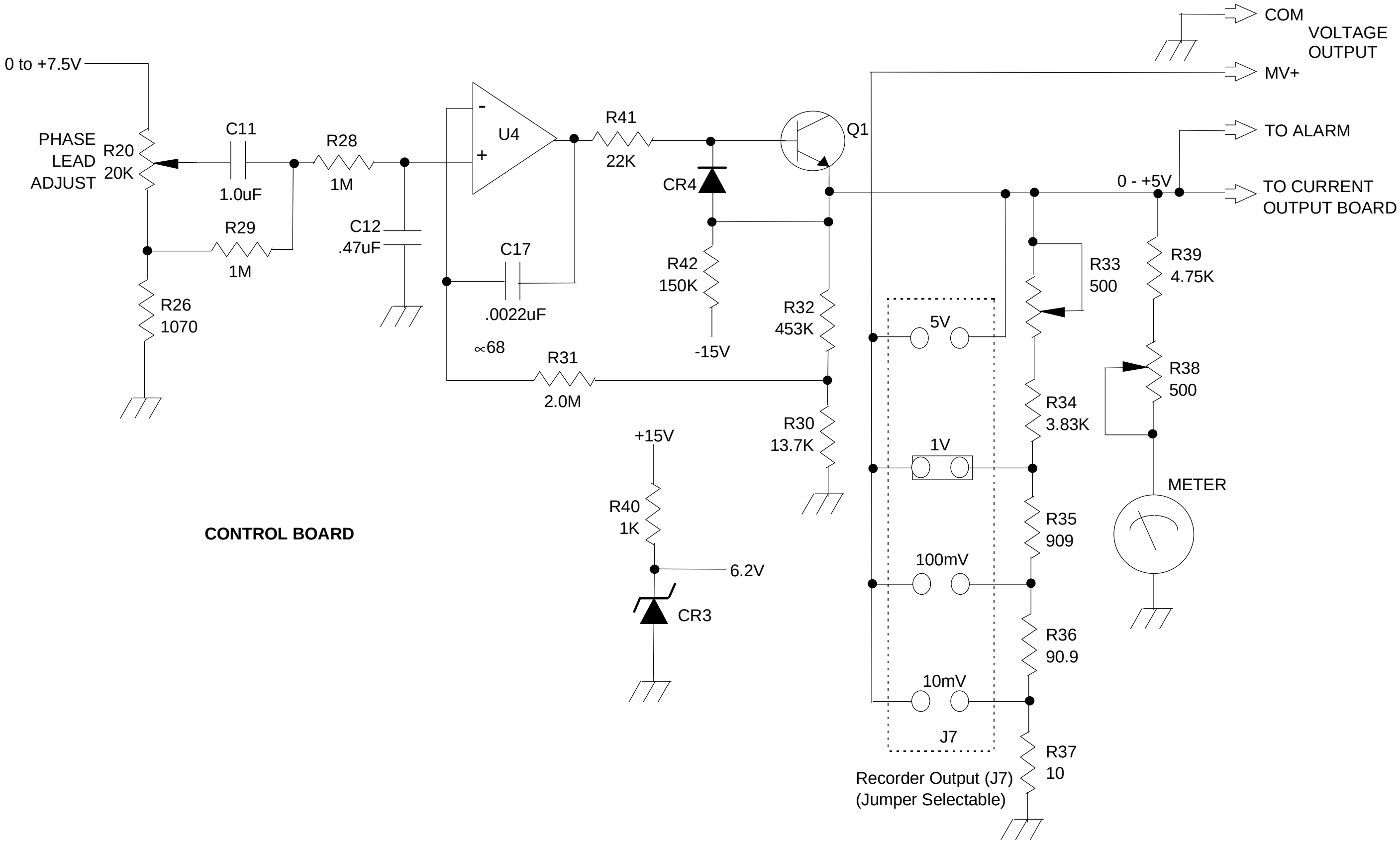


FIGURE 6-7. FINAL OUTPUT AMPLIFIER

6.7 ZERO SUPPRESSION MODULE FOR ZERO ADJUSTMENT

The zero suppression module plugs into J6 and supplies an adjustable negative voltage to front-panel ZERO potentiometer R10. This voltage is adjustable from about -10 VDC to 0 VDC. The adjustment allows elevation of the measurement span and/or compensation for altitude change, see Figure 6-8.

The +10 VDC is a reference value from the regulator U1 (designated PM REF). Potentiometer R45 allows adjustment of the input to amplifier AR5. The output can vary from approximately -10 V to -4 VDC. Front-panel ZERO potentiometer R10 is now connected into the output of the zero suppression module. This configuration is obtained through use of the proper range resistor module designed for zero suppression. In a standard range resistor module for zero-based ranges, R10 is located between a +15 V, -15 VAC supply.

The voltage drop across R10, between the wiper and the output of AR5, is divided by the resistance divider made up of R25 and R44 in parallel and the number of range resistances in series selected by front panel RANGE Switch SW1. This divided, or selected, voltage is applied to the input of amplifier U2 (Figure 6-8) to provide the amount of zero suppression that corresponds to the lower range-limit of the zero-suppressed range.

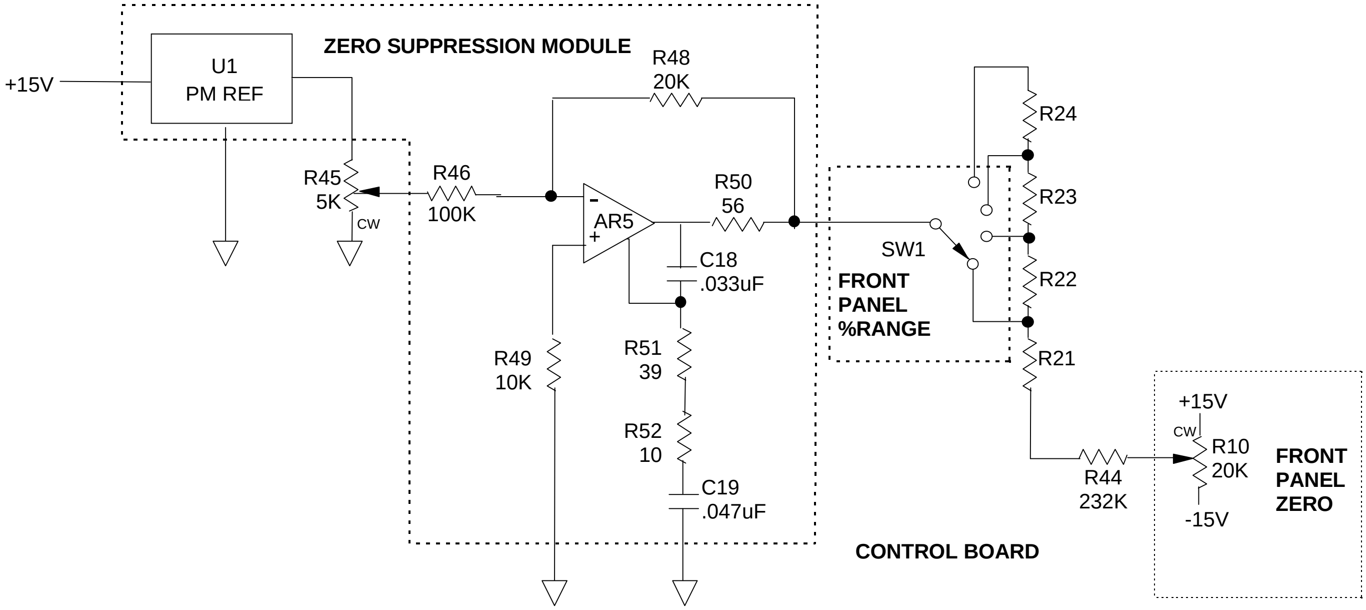


FIGURE 6-8. ZERO-SUPPRESSION MODULE

7

SERVICE AND MAINTENANCE

The information provided in this section will aid in isolation of a malfunction to a particular assembly or circuit board. A few detailed checks are included to aid location of the defective assembly. It is recommended that those familiar with circuit in analysis refer to the circuit theory presented in Section Six of this manual.

WARNING: 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

If explosive gases are introduced into this analyzer, the sample containment system must be carefully leak-checked upon installation and before initial start-up, during routine maintenance and any time the integrity of the sample containment system is broken, to ensure the system is in leak-proof condition. Leak-check instructions are provided in Section 2.7.

CAUTION: PARTS INTEGRITY

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

7.1 INITIAL CHECKOUT WITH STANDARD GASES

If instrument readings do not meet specifications, the first step in troubleshooting is to isolate the analyzer from the sample stream and the sample-handling system.

Admit downscale and upscale standard gases to the analyzer; observe readout on meter, and on recorder if used:

Meter reads correctly with standard gases but not with sample gas, the sample and the sample-handling system are suspect. Check these areas.

Meter reads correctly with standard gases but the alarm or output devices do not, these devices must be checked individually.

Meter reads offscale or erratic with standard gases, as well as with sample gas, the trouble is probably in the detector or the electronic circuitry.

- *Offscale* - Indication. If meter drives offscale in either direction, turn off power; tap detector compartment with fingers; wait 30 seconds; then again apply power. If the suspension within the detector assembly is hung up, this procedure may correct the condition. If not, proceed with tests of detector and electronics.
- *Erratic* - If downscale and upscale standard gases give noisy or drifting readings, the trouble is probably in the detector or the temperature-control circuits. Proceed with test of detector and electronics. In general, before concluding that the detector is defective and must be replaced, it is desirable to verify correct operation of all circuits that could cause erratic readings.

TROUBLESHOOTING ZERO - SUPPRESSED RANGE INSTRUMENTS

In troubleshooting an analyzer that has zero-suppressed ranges only, the use of a zero-based range change kit is recommended. In the initial troubleshooting, the zero-based range resistor module is installed temporarily, to provide a temporary zero-based range. Analyzer readout may then be checked with 100% nitrogen as the downscale standard gas and air (20.93% O_2) as the upscale standard gas. Such testing will also eliminate the effects of variations in barometric pressure and sample pressure. These effects are sometimes difficult to diagnose on zero-suppressed ranges.

7.2 CHECKOUT AT TEST POINTS ON CASE CIRCUIT BOARD

Initial checks are made at test points A, B, C and D on the Case Board. There are two sets of these test points for accessibility. See Figure 7-1.

Test points A, B, C, and D permit connection to the photocells and the suspension of loop. Locations of the test points within the detector circuit are as shown in Figure 7-2.

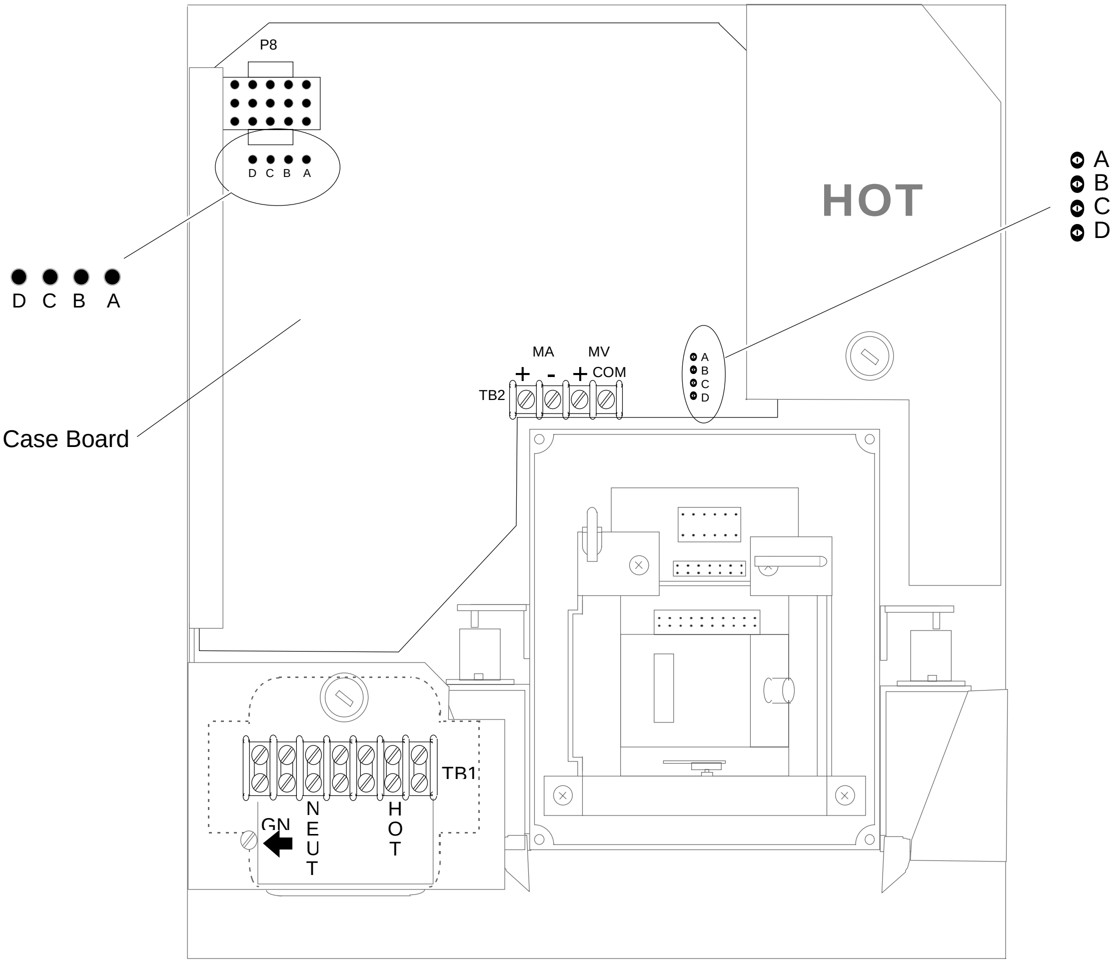
With zero gas flowing, connect a voltmeter across B and A; measure voltage and note polarity, then. measure voltage from C or D to ground and note polarity. Check results against table, Voltage Test Measurements.

VOLTAGE TEST MEASUREMENTS

B TO A	C OR D TO GROUND	DIAGNOSIS	CORRECTIVE ACTION
-	+	Normal	NA
+	+	U1 or U2 defective	Replace case board
-	-	U1 or U2 defective	Replace case board
+	-	Detector defective	Check detector per Section 7.3

If polarities are correct, set front-panel SPAN potentiometer R4 at maximum. The output at pin 6 of U3 should be 7.5 VDC. Pins 2 and 3 of U4 should both be at 0.465 VDC, resulting in 5 VDC at the output of Q1 .

Checkout of the case circuit board is now complete.



Alarm Option removed for clarity.

FIGURE 7-1. LOCATIONS OF CASE BOARD TEST POINTS A, B, C AND D

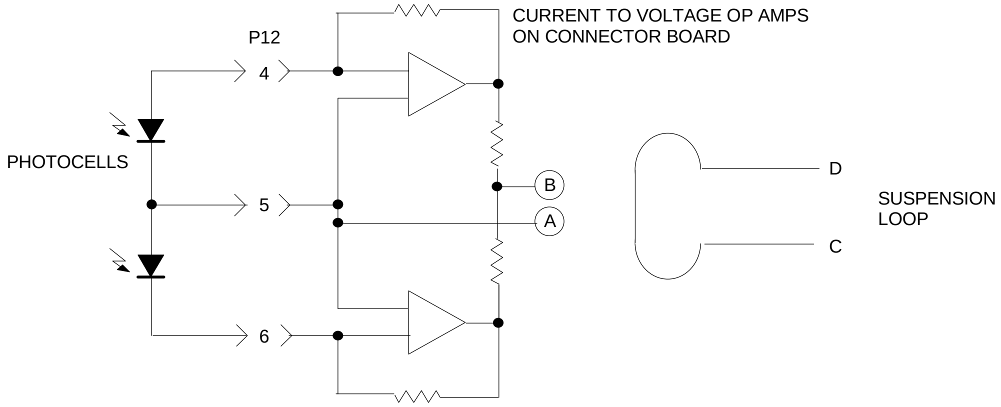


FIGURE 7-2. VOLTAGE TEST POINTS

7.3 DETECTOR COMPONENT CHECKOUT

7.3.1 DETECTOR

Before concluding that the detector is defective and must be replaced, verify that all components and circuits that could cause erratic readings are operating properly.

To isolate the detector as a source of a problem, the source lamp, photocells, and suspension should be checked for proper operation.

7.3.2 SOURCE LAMP

To verify that the source lamp in operating properly:

1. Verify that lamp is lit.
2. Voltage at U7 pin 2 should be 2.2 ±0.2 VDC.

If lamp is not operating properly, replace per instructions in Section 7.4.2.

7.3.3 PHOTOCELL

To verify that photocell is operating properly, perform the following steps:

1. Keeping power source ON, disconnect the leads of the photocell from connector J12. See Figures 7-3, 7-4.
2. Note the current measurement between the gray and orange wires (between 300 to 450 mA).
3. Measure between the orange and red wires. The reading should be approximately the same as step 2.

If photocell readings not correct, replace photocell per Section 7.4.3.

7.3.4 SUSPENSION

If the suspension has been damaged, the cause may be improper operating conditions.

Maximum permissible operating pressure for the detector is 10 psig (69 kPa gauge pressure). To ensure against over-pressurization, a pressure relief valve may be inserted into the sample inlet line. In addition, a check valve should be inserted into the vent line, if connected to a manifold associated with a flare or other outlet that is not at atmospheric pressure. If the detector is over-pressurized, the suspension could break.

To verify correct operation:

1. Turn electrical power to analyzer OFF.
2. Remove optical bench assembly (see Section 7.4.2, steps 1 through 4.)
3. With 100% nitrogen flowing through the analyzer, note the position of the suspension.
4. Admit air and note response of suspension. It should rotate clockwise (as viewed from the top) and to the right (as viewed through the window).

Failure to rotate indicates that the suspension has been damaged and that the detector assembly must be replaced. See Section 7.4.1.

7.4 DETECTOR COMPONENT REPLACEMENT

7.4.1 DETECTOR REPLACEMENT AND CALIBRATION

REPLACEMENT

Prior to removal of the detector, remove power from instrument and stop flow of sample gas.

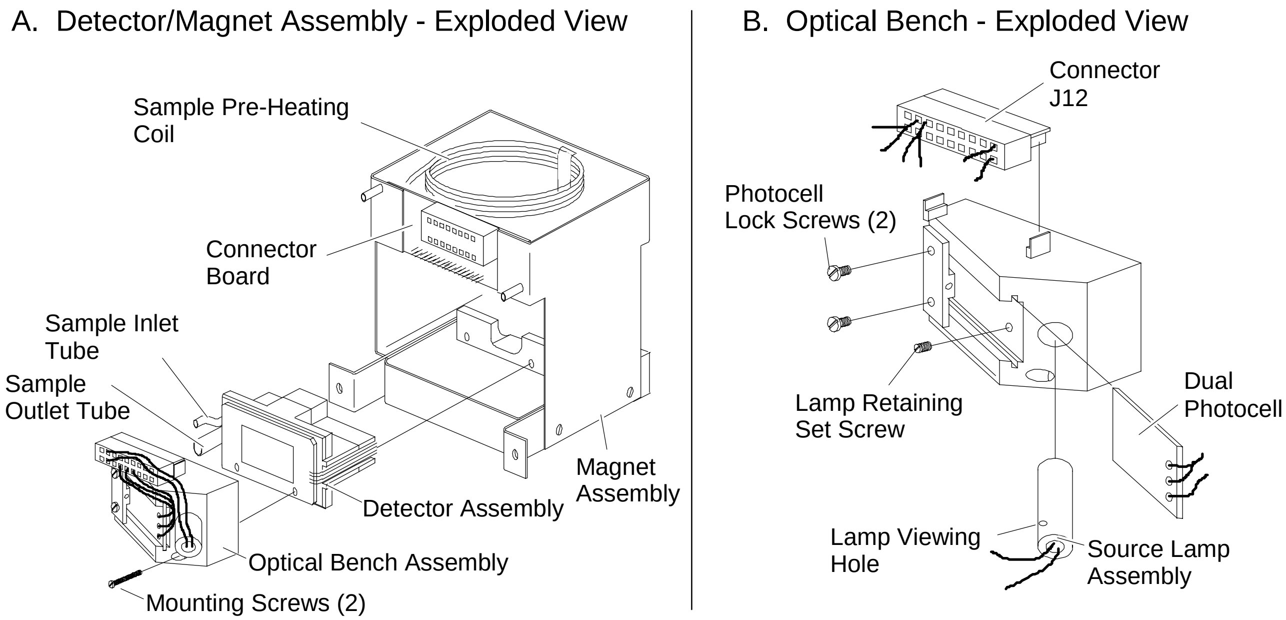
1. Remove the four screws securing the detector cover plate.
2. Disconnect cable from J12 on the detector assembly.

Note

Note how the rubber sample lines are looped into a "long coil". When reinstalling the sample lines they must be configured in the same way. This precaution isolates the detector from the effects of mechanical vibration. Otherwise vibration waves could travel upward along the tubing walls, resulting in noisy readout.

3. Refer to Figure 7-3. Using needle-nose pliers, squeeze the hose clamps to disconnect the rubber sample lines from the metal inlet and outlet tubes of the detector assembly.

4. Remove the two screws at the bottom of the detector assembly, slide detector out.
5. Install replacement detector assembly and connect cable to J12.
6. Seat the detector assembly firmly against the magnet pole pieces and tighten attaching screws.
7. Reconnect rubber sample lines to metal inlet and outlet tubes on detector assembly.
8. Apply power to instrument and allow to warm up approximately one hour.


A. Detector/Magnet Assembly - Exploded View

B. Optical Bench - Exploded View

FIGURE 7-3. DETECTOR/MAGNET ASSEMBLY

CALIBRATION

Note

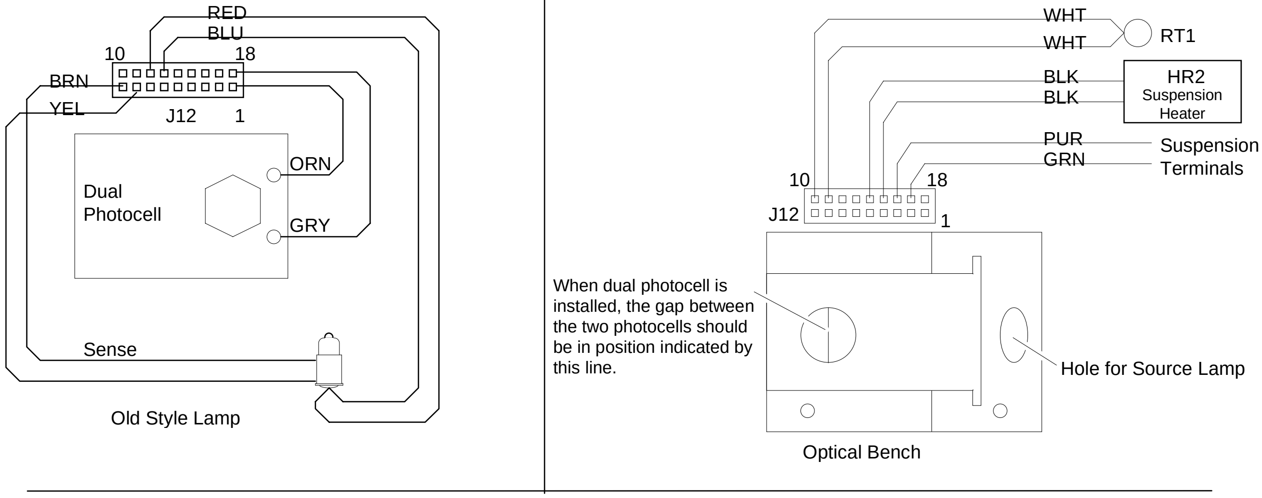
The following adjustments are on the control board, refer to Figures 1-1 and 3-1.

1. Connect a digital voltmeter (4-digit resolution) from slider (S) of front-panel ZERO potentiometer (R10) to chassis ground. Adjust ZERO potentiometer for zero volts.
2. Connect the voltmeter from wiper of front panel RANGE switch (SW1) to chassis ground. Adjust Zero Suppression Adjustment (R45) for voltmeter reading of as near zero as possible.
3. Connect the voltmeter from slider (S) of front panel SPAN potentiometer (R4 to chassis ground. With a steady flow of 50 to 500 cc/min. of nitrogen zero gas passing through the instrument, adjust Coarse Zero Potentiometer (R92) for zero volts.

4. If instrument has zero-suppressed ranges, proceed to Step 13. If instrument has zero-based ranges, skip Step 13 and proceed directly to Step 14.
5. If instrument has zero-suppressed ranges, the zero offset required for the desired zero-suppressed range must now be established. Supply a steady flow of downscale standard gas appropriate to the desired range, refer to Section 3.2. Set Zero-Suppression Adjustment (R45) so that the reading on the front-panel meter is appropriate to the downscale standard gas. The required reading may be the actual oxygen content of the downscale standard gas, or may be an adjusted value, depending on the relative magnetic susceptibilities involved, and the range and span used, refer to Section 3.3.2.
6. With all internal adjustments now properly set, the instrument may be calibrated in the normal manner by adjustment of the front-panel ZERO and SPAN controls.

Note

If subsequently the analyzer ranges are changed through installation of a different range resistor module, the calibration procedure of Steps 9 through 14 must be repeated.


A. Connections to Source Lamp and Photocell

B. Connections to Suspension and Heater Circuits

C. Removal and Insertion of Pin/Leads in Connector J12

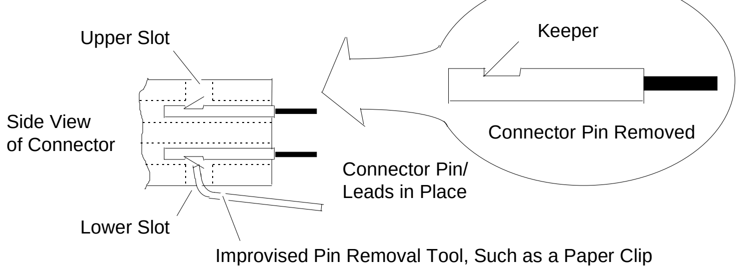
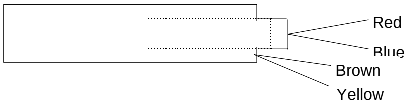


FIGURE 7-4. DETECTOR/MAGNET ASSEMBLY WIRING

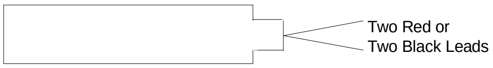
7.4.2 SOURCE LAMP REPLACEMENT AND ADJUSTMENT

REPLACEMENT

1. Remove the four screws securing the detector assembly cover plate.
2. Refer to Figure 7-3. Carefully remove the small rubber hose connected from the detector/magnet assembly to the detector.
3. If retaining set screw for lamp is accessible, proceed to step 6. If the set screw is not accessible continue to step 4.
4. Remove the two screws holding the optical bench assembly/detector assembly to the magnet assembly. Carefully remove optical bench and detector assembly.
5. Remove the two lock screws (2-56 X 5/16 pan head) holding the photocell in the optical bench. Carefully remove photocell.
6. Loosen lamp retaining set screw, remove lamp.
7. Note location of lamp wires in connector J12. Disconnect leads of lamp assembly from connector J12 (see Figure 7-4A) using method shown in Figure 7-4C.
8. Depending on date of manufacture of the analyzer, the original lamp assembly may be either of two types:
   7. Old style lamp assembly with four color coded leads: Red, blue, brown and yellow.



   8. New style lamp assembly with two leads color coded either both red or both black.



The replacement lamp assembly is the new style with two leads. On J12, insert one lead into the position formerly used for the brown lead to the old style lamp and the other lead into the position for the blue lead of the old lamp. See Figure 7-4A.

9. Insert the lamp into the assembly. After reassembly and application of power, the lamp will have to be rotated to place the lamp filaments in proper orientation.
10. If the lamp assembly removed from the instrument has *two* wires, proceed to step 13.
11. If the lamp assembly removed from the instrument has *four* wires, the Connector Board requires modification per steps 10 through 12. Continue to step 10.
12. Refer to Figure 7-3. Remove the two screws holding the Connector Board to the magnet assembly. Carefully remove Connector Board.
13. Place Connector Board on a clean working surface, with solder side (no components) up.

14. Per Figure 7-5, add straps or solder bridges at the two points shown.

Note

If the Connector Board cannot be satisfactorily modified, a modified 633689 Connector Board may be ordered from the factory. See Section 8.

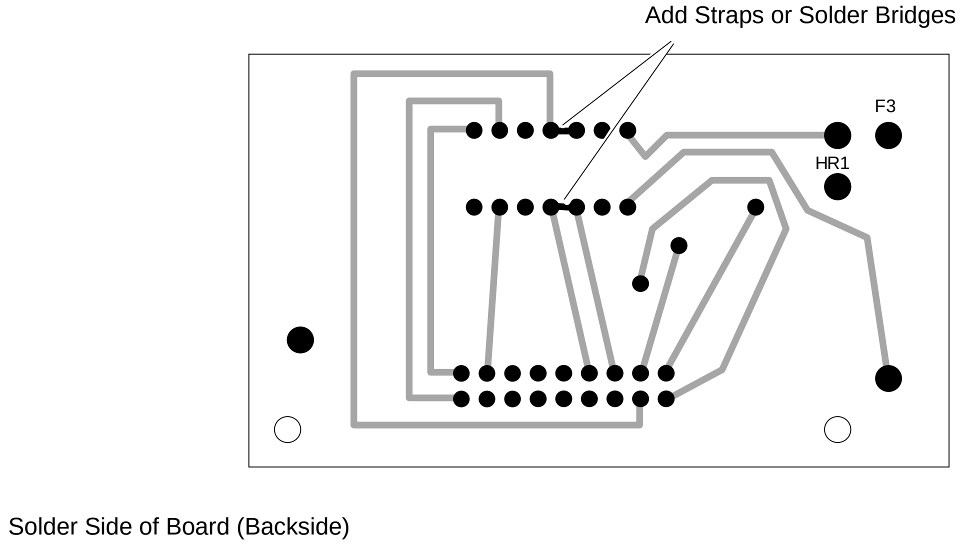


FIGURE 7-5. MODIFICATION OF 633689 CONNECTOR BOARD FOR COMPATIBILITY WITH REPLACEMENT LAMP

15. Reassemble detector, etc., in reverse order of disassembly.

ALIGNMENT

The lamp has a red line on the base housing. It is to be lined up with the set-screw that secures the lamp, see Figure 7-6. The base of the lamp should extend from the hole approximately 1/4 inch, then tighten the set-screw.

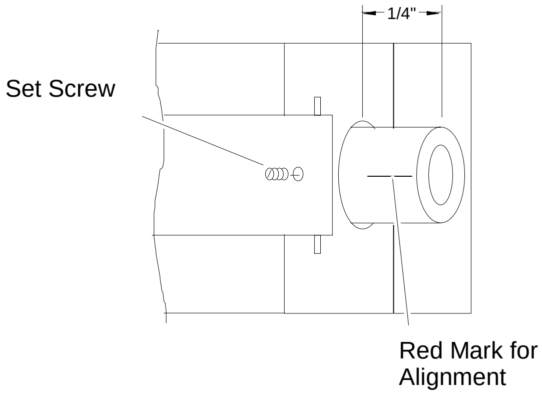


FIGURE 7-6. LAMP ALIGNMENT

The photocell will need realigning per subsection 7.4.3.

7.4.3 PHOTOCELL REPLACEMENT AND ALIGNMENT

In removing photocells for examination, testing, or replacement, use the following procedure. The range resistor module, and zero suppression module. if used, must be installed.

REPLACEMENT

To remove the photocell from the optical bench, perform steps 1 thourgh 5 of Section 7.4.2.

Install replacement photocell by reversing the procedure.

ADJUSTMENT

Note

The following adjustments are on the control board, refer to Figures 1-2 and 3-1.

1. With zero gas flowing:
    a. Place a digital voltmeter on the wiper of the zero potentiometer (R10) and TP7 (ground), and adjust for 0 VDC.
    b. Place the voltmeter from the left of R91 and TP7, and adjust R92 for 0 VDC, see Figure 7-7.
    c. Place the voltmeter on TP8 and TP7, then move the photocell to obtain a direct-volt voltage as close to 0 mV as possible but no more than ±750mV.
2. Apply power to instrument and allow to warm up for about one hour.
3. Perform the Calibration procedure in Section 7.4.1.

With all internal adjustments now properly set, the instrument may be calibrated in the normal manner by adjustment of the front-panel ZERO and SPAN Controls.

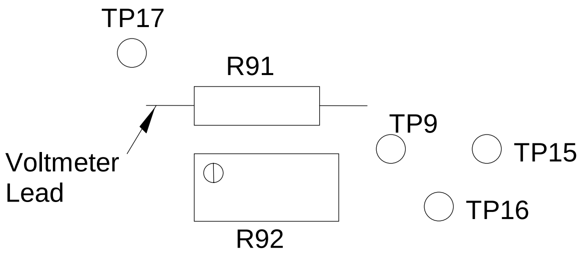


FIGURE 7-7. PHOTOCELL ADJUSTMENT VOLTMETER LEAD LOCATION

7.5 HEATING CIRCUITS

To ensure against damage from overheating in event of malfunction, the heating circuits receive power via thermal fuses F2 and F3. If temperature of a heated area exceeds the permissible maximum, the associated fuse melts, opening the circuit. Each thermal fuse should be plugged in, not soldered, as the fuse element might melt and open the circuit.

7.5.1 CASE HEATER CONTROL CIRCUIT

The case heater control circuit receives power via thermal fuse F2 (setpoint 76°C). This fuse, accessible on the case circuit board, may be checked for continuity.

Case heater element HR3, mounted on the heater/fan assembly, has a normal resistance of 20 ohms.

To verify heater operation, place a hand beside the right hand side of the detector housing. Heated air should be felt; if not, check the case heating circuit.

Temperature sensor RT1 has a cold resistance of 22.7K ohms and a normal operating resistance of 20.2K ohms, indicating normal operating temperature of 140°F (60°C). Until thyristor RV1 reaches operating temperature. it bypasses most of the current that would otherwise flow through TRIAC Q7.

As a further check, disconnect plug P8 on the control board assembly, thus disconnecting temperature sensor, RT1. Substitute a decade resistor box to simulate the resistance of RT1. Also connect an AC voltmeter from the hot side of the line to the neutral side of F2.

CAUTION: EQUIPMENT OVERHEATING

Do not operate for long periods of time with decade box set for 22.2K ohms, as overheating of equipment may result.

Set the decade box for 20.2K ohms to simulate RT1 resistance at controlling temperature. The voltmeter should now show pulses of 1 VAC.

Set the decade box for 22.2K ohms to simulate RT1 resistance at ambient temperature; the voltmeter should now show pulses of 120 VAC.

7.5.2 DETECTOR/MAGNET HEATING CIRCUIT

Heater HR1 is attached to the magnet: heater HR2 is attached to the rear of the detector. Combined resistance of these two parallel-connected heaters, as measured at pins 15 and 16 of detector connector J12, should be approximately 17 ohms. If not, remove pin/leads 14 and 15 from the connector, to measure resistance of HR2 alone.

This resistance should be approximately 89 ohms. If resistance was correct, and yet the combined resistance was incorrect, heater HR1 may be open. To reach the leads of HR1. remove the printed circuit board on the heater assembly. Resistance of HR1 should be approximately 21 ohms.

To check operation of the heater circuit, connect a voltmeter across R61 on the case circuit board . Normally the voltage will be 4 VDC when cold, and will drop to approximately 0.4 VDC at control temperature. Temperature sensor RT1 is mounted in the detector with leads accessible at pins 10 and 11 of detector connector J12. The sensor resistance, as measured at these pins, should be 1M ohms at 25°C and approximately 149K ohms at operating temperature of 65°C.

8

REPLACEMENT PARTS

The following parts are recommended for routine maintenance and troubleshooting of the Model 755 Oxygen Analyzer. If the troubleshooting procedures do not resolve the problem, contact your local Rosemount Analytical service office. A list of Rosemount Analytical Service Centers is located in the back of this manual.

WARNING: PARTS INTEGRITY

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

8.1 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.

8.2 REPLACEMENT PARTS

To minimize downtime, stocking of the following spare parts is recommended.

656143	Detector, 0-5% or greater range increments	1*
622421	Optical bench, for detector 632358	1*
656190	Detector/Optical bench assembly, corrosion resistant, 0 to 1 % or greater range increment	1*
656189	Detector/Optical bench assembly, non-corrosive applications, 0 to 1 % or greater range increments	1*
616418	Source lamp kit	1
622356	Photocell assembly	1
631773	Case circuit board assembly	1
623875	Control board assembly	1

861273	Fan (120 V)	1
860706	Fan (240 V)	1
861652	Heater (120 V)	1
861653	Heater (240 V)	1
621023	Current output board, 0 to 20 mA, 4 to 20 Ma	1*
860371	Alarm relay	1*
861649	Thermal fuse (F2-F3)	1

*If used

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.

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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.

Rosemount Analytical

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FIELD SERVICE AND REPAIR FACILITIES

Field service and repair facilities are located worldwide.

U.S.A.

To obtain field service on-site or assistance with a service problem, contact (24 hours, 7 days a week):

National Response Center
1-800-654-7768

INTERNATIONAL

Contact your local Rosemount Sales and Service office for service support.

FACTORY

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

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

RETURNING PARTS TO THE FACTORY

Before returning parts, contact the Customer Service Center and request a Returned Materials Authorization (RMA) number. Please have the following information when you call: *Model Number, Serial Number, and Purchase Order Number or Sales Order Number.*

Prior authorization by the factory must be obtained before returned materials will be accepted. Unauthorized returns will be returned to the sender, freight collect.

When returning any product or component that has been exposed to a toxic, corrosive or other hazardous material or used in such a hazardous environment, the user must attach an appropriate Material Safety Data Sheet (M.S.D.S.) or a written certification that the material has been decontaminated, disinfected and/or detoxified.

Return to:

Rosemount Analytical Inc.
4125 East La Palma Avenue
Anaheim, California 92807-1802

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