

Instruction Manual

Terranova

Model 924A

Thermocouple Vacuum Gauge Controller



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rev070908sr

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Safety Information

Explosive Gases

WARNING!

Do not use the Model 924A Thermocouple Gauge Controller to measure the pressure of combustible gas mixtures. The gauge normally operates at low temperatures, but it is possible that momentary transients or controller malfunction can raise the gauge above the ignition temperature of combustible mixtures, which then might explode and cause damage to equipment and injury to personnel.

Limitation on use of Compression Mounts

WARNING!

Do not use a compression mount (quick-connect) for attaching the gauge tube to the vacuum system in applications that may develop positive pressures. Positive pressures may cause the tube to be blown out of a compression fitting and damage equipment and injure personnel.

Chemicals

WARNING!

Many organic cleaning solvents, such as acetone, produce fumes that are toxic or flammable. Use such solvents only in areas that are well ventilated to the outdoors and away from electronic equipment, open flames, or other potential ignition sources

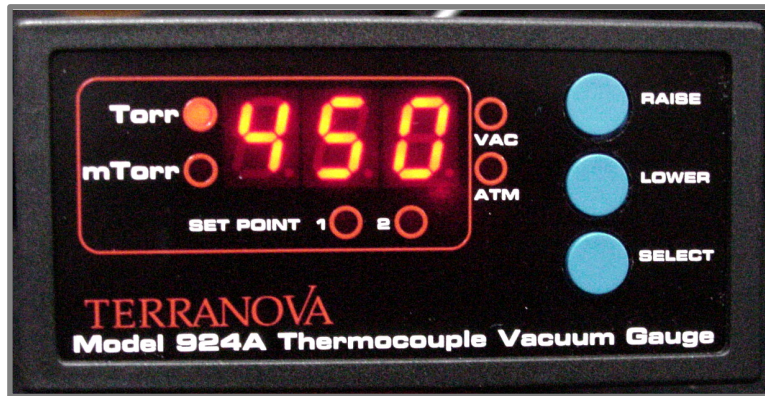


Figure 1: Model 924A Front View

Dimensions – standard 1/8 DIN enclosure

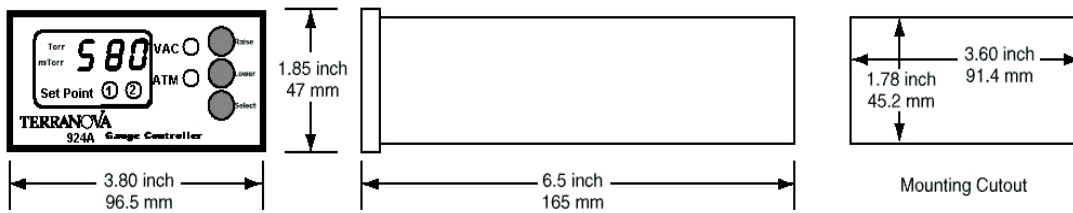


Figure 2: Model 924A Dimensions

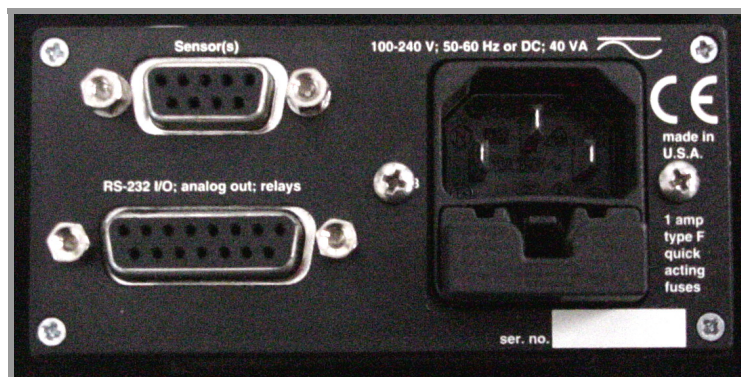


Figure 3: Model 924A Rear View

I Overview

C. General Description

The Terranova Model 924A Thermocouple Vacuum Gauge Controller displays vacuum pressure as measured from a 531-type Thermocouple gauge tube. It displays vacuum measurements based on thermal conductivity of air or nitrogen. The Model 924A controller covers the range from 1 mTorr to 1000 Torr or 1 μ bar to 1000 mbar, and controls two relays with independent set points.

D. Specifications

1. Useful Measuring Range

1 mTorr (μ bar) to 990 Torr (mbar), for air or nitrogen; (10^{-3} torr (mbar) to 10^3 torr (mbar)); range selection is automatic

2. Display Range

-19 mTorr (μ bar) to 990 torr (mbar); pressures lower than -19 mTorr (μ bar) display LO; pressures higher than 990 torr (mbar) display HI; if cable is not plugged in display shows OFF

3. Units of Display

torr or mBar; must be specified at time of ordering

4. Vacuum Gauge

Varian 531 or 536 thermocouple gauge or equal

5. Operating Temperature Range

+2 to +50 deg. Celsius

6. Pressure Display

3-digit bright red LED, 10 mm high

7. Display Indicators

bright red LED for VAC, ATM, SET PT 1, SET PT 2

8. Display Resolution

varies; from 1 mTorr (μ bar) below 10 mTorr (μ bar), to 20 Torr (mbar) above 100 Torr (mbar)

9. VAC and ATM Adjust

adjusted by front panel push-button

10. Process Control Set Points

two, adjusted by front panel push-button

11. Process Control Relays

two relays, 3 amp, 240 VAC contacts; independent Normally Open and Normally Closed; +5 volts is provided for TTL applications; available through the DB15 accessory connector

12. Nonvolatile Memory

for VAC, ATM and SET POINTS

13. Analog Output

calibrated, 12-bit resolution, logarithmic, 0.50 volts/decade; 0.0 mTorr (μ bar) = 0 volts; 10 mTorr (μ bar) = 0.50 volts; 100 mTorr (μ bar) = 1.00 volts; etc.; available through the DB15 accessory connector

14. RS-232 Input/Output

allows user to read pressure and set points; 9600 baud, 8-N-1; available through the DB15 accessory connector

15. Operating Voltage

the Model 924A has a universal power supply, which operates on input voltages from 85 VAC to 240 VAC 50/60 Hz; standard IEC 320 instrument power input receptacle on rear panel; replacement fuse type: 5 mm X 20 mm, regular or slow-blow 1 amp

<u>manufacturer</u>	<u>fuse type</u>
Bussman	GDB-1A or GDC-1A
Littlefuse	217 001 or 218 001

16. Weight

1 lb. / 0.5 kg

17. Mounting

Side clips are provided for panel mounting in standard 1/8 DIN cutout.

18. Environmental Considerations

not for use with explosive or corrosive gases

19. Thermocouple gauge tube:

Thermocouple Vacuum Gauge, series 531 available from Duniway Stockroom.

Duniway Stockroom
tel (800) 446-8811 or (650) 969-8811 (California)
Facsimile (650) 965-0764

II Installation

A. Unpack the Controller

Carefully unpack the Model 924A Thermocouple Vacuum Gauge Controller. The shipment includes these components:

- controller unit
- power cord
- mounting clips
- DB15 accessory connector
- this instruction manual

If your controller does not have all of these items, call Duniway Stockroom. If it appears to have been damaged in shipment, contact the shipper.

B. Mount the Controller

You can mount the controller unit freestanding on a bench, table top, or shelf, or you can mount it in a rack or cabinet. The controller unit is housed in a standard 1/8 DIN box.

If you are mounting the unit in a panel, the cutout dimensions are 44 mm by 92 mm. One mounting clip attaches to each of the sides of the controller unit. To attach the clip, slide the beveled surfaces of the clip under the cutout on the side of the box and push the clip toward the back of the unit until the central tongue locks the clip in place. Then slide the unit into the panel; the clips will hold the unit in place.

Be sure to leave enough clearance at the back of the controller unit for easy access to cable connections.

C. Select the Gauge Tube

The Model 924A controller is designed to work with the industry-standard 531 thermocouple gauge tube. See **Specifications** for availability of thermocouple gauges. If you have difficulty obtaining the thermocouple gauge, please contact us at Duniway Stockroom.

CAUTION

Use of a gauge tube other than the 531 or 536 may cause improper readings, and may cause damage to the gauge tube.

D. Connect the Gauge Tube

Make sure that the gauge tube is securely connected to the vacuum system, using good vacuum practice. The required orientation for the thermocouple gauge tube is with its axis vertical, and the port pointing down; large errors will result at higher pressures if the gauge axis is not vertical.

E. Attach the Gauge Cable

The gauge cable, which connects the gauge tube to the controller unit, has an octal connector for the thermocouple gauge on one end and a 9-pin D type connector on the other. Be sure to use the cable supplied with the Model 924A or contact us for a replacement cable.

CAUTION

Make sure that the power to the controller unit is off before you connect the gauge tube to the controller unit. Unplugging and then plugging in the gauge cable with the power on can cause the thermocouple gauge to burn out.

Connect the gauge cable to the thermocouple gauge tube. Align the keyway of the connector with the key on the thermocouple gauge tube, and push the connector onto the gauge tube's pins until it seats firmly.

Connect the 9-pin male D plug of the gauge cable to the 9-pin female D connector (see diagram below) on the back of the controller unit and fasten the retainer screws on each side.

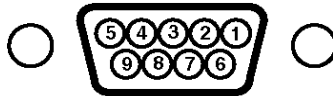


Figure 4: 9 Pin Female Connector on Rear Panel - Terranova 924A

NOTE

If you need to make a special cable, the following description will give the proper connections. The unique constant-current source drive of the Model 924A allows interface to thermocouples over great distances. Select wire size to keep resistance less than 2 ohms.

<u>octal thermocouple connector pin</u>	<u>9-pin controller connector</u>	<u>wire color</u>
3	9	black
5	8	white
7	3	drain
1	1	red

F. Make Relay Connections

You can set two process control set points from the front panel of the controller (SET PT 1) and (SET PT 2). The set points control two relays that are accessible through the connector on the back of the controller. SET PT 1 controls relay #1, and SET PT 2 controls relay #2. Relay contacts are available through the DB15 Accessory Connector.

G. Accessory Connector

The accessory Connector is on the rear panel of the 924A. There are two DB15 connectors; the Accessory Connector is the top connector. The connector has female pins, the mating connector must have male pins. Mating DB15 connectors are available from many of the normal electronic sources. If you need help identifying a source, please contact us. Following are pin assignments for the Accessory Connector:

<u>pin</u>	<u>function</u>
1	normally closed contact for set point relay 1
2	armature/wiper for set point relay 1
3	normally open contact for set point relay 1
4	normally closed contact for set point relay 2
5	armature/wiper for set point relay 2
6	normally open contact for set point relay 2
7	Tx for RS-232 interface (see Serial Interface)
8	Rx for RS-232
9,10,11,14,15	ground, electronics common
12	+5 volts, supplied through 1K resistor, for TTL use
13	analog output, 0.5 volt/decade (see Analog Output)

H. Attach the Power Cord

Plug the power cord into the receptacle in the power module. Plug the other end of the power cord into an electrical outlet.

III Operation

A. Turn Power On

The loudspeaker will “beep” and all indicators will light for a few seconds while the controller executes its self test. After the self-test, the display will show the software version, e.g. **1.01** for a second; then it will display the units of measure, torr or mbar, e.g. **TOR** or **BAR** for one second. The 924A will then begin measuring pressure. If the gauge cable is not connected, the display will show **OFF**. If the system pressure is greater than 990 Torr (mbar) or if the gauge is disconnected from the cable, the display will show **HI**.

B. Calibration

You can set the zero point of the display or calibrate it to atmospheric pressure; in addition, you can recover the factory settings. These calibrations use the SELECT, RAISE and LOWER buttons.

C. Setting to Zero

The system pressure should be less than 1 mTorr (mbar). Press the button labeled SELECT. You will hear a short ‘chirp’ from the loudspeaker and the VAC LED will flash; you may now use RAISE and LOWER to set the pressure to zero. The actual pressure must be less than approx. 50 mTorr (65 mbar); if you try to set zero pressure when the instrument is greater than 50 mTorr (65 mbar), you will get a long beep from the loudspeaker.

D. Setting Near Zero

The display may be set to a specific value near zero. For example, if you know that the system pressure is 10 mTorr (mbar), you can set the display to agree with this value, as follows: while in VAC adjust, press RAISE or LOWER to set to the desired value. If the system pressure is greater than approx. 50 mTorr (65 mbar), you cannot make these adjustments.

E. Setting Atmosphere

You should know the local barometric pressure before proceeding; your local airport may have this information. Normal pressure is approximately 760 Torr (1000 mbar) at sea level.

Press the button labeled SELECT until the ATM LED is flashing. You may now use RAISE and LOWER to set the pressure to the desired pressure. If you try to set ATM pressure when the pressure is less than approx. 200 torr (350 mbar), you will get a long beep from the loudspeaker. As the display changes, you will hear a series of ‘chirps’ from the loudspeaker.

F. Reset of Stored Values

This allows recovering the factory settings for VAC and ATM and resets SET POINTS to minimum: For a system that is far out of calibration, the factory settings provide a good starting point for re-calibrating the gauge controller. This procedure also enters **OFF** for the set points. To recover the factory settings, unplug the 924A for its line voltage power source. Press and hold RAISE and LOWER buttons at the same time; plug the power cord in. You will hear a few short ‘chirps’ from the loudspeaker confirming the factory settings have been entered.

G. Changing Units of Measurement

This allows you to change from measurement in Torr to mBar or from mBar to Torr. The internal software allows the 924A to display pressure in either Torr or mBar. The 924A is shipped with the unit of measure which was specified at the time of the order. If you wish to change the units of measure, remove power from the 924A by unplugging it from the AC mains. Press and hold all three buttons, SELECT, RAISE and LOWER; plug the AC power in and wait for the two “chirps” from the loudspeaker to confirm the units change. After the display self-test, the display will show **TOR** or **BAR**, to confirm the selected units. Make certain that the labels on the front panel units (torr and mTorr; or μ bar and mbar) match the selected units. If you need a different display overlay, please let us know. This procedure is a bit inconvenient, but it is not intended to be a function that is changed often.

H. Set Point Operation

When the displayed system pressure is less than the value of the set points, the set point relay is turned on; the corresponding LED lights to indicate that the relay is energized. The relay will be turned off when the pressure rises to 5% above the set point, plus 1 mTorr. For example:

If the set point is 30 mTorr, the set point relay will turn on at 30 mTorr; it will turn off at $[30 + 0.05*30 + 1]=32.5$ mTorr, and higher pressures.

If the set point is 3 mTorr, the set point relay will turn on at 3 mTorr; it will turn off at $[3 + 0.05*30 + 1]=4.0$ mTorr, and higher pressures.

If the set point is 1 torr, the set point relay will turn on at 1.00 torr; it will turn off at $[1.00 + 0.05*1.00 + 0.001]=1.05$ torr, and higher pressures.

NOTE: See also Section VI - Application Note - Protective Circuits for Set Point Relays

I. Reading the Set Points

To see the value of a set point, push the SELECT button until the desired SET PT LED is flashing.

J. Setting the Set Points

The range for the set point settings is from 3 mTorr (mbar) to 500 torr (mbar). The **OFF** setting disables the set point control and keeps the relays from operating. The **OFF** setting is the lowest setting, below 3 mTorr (μ bar).

To set a set point, push the SELECT button until the desired SET PT LED is flashing. The display will indicate the current value of the set point. Use the RAISE and LOWER buttons to adjust the set point to the desired value. As the indication changes, you will hear short 'chirps' from the loudspeaker.

NOTE:

When using the SELECT button, the display will remain in the selected function until the SELECT button is pushed again; or if no button is pushed for 60 seconds, the instrument will revert to normal operation. This automatic reset is to prevent any error to process control if the instrument is left in the adjust mode.

K. Analog Output

The analog output is calculated from the value of the digital display. The output is logarithmic, 0.5 volt/decade; the source impedance for the output is 10 K ohm. The output voltage is calculated from:

$$V=0.500(\log_{10}P)$$

where V is the Analog Output in volts; P is the pressure in mtorr or μ bar.

The pressure as a function of the Analog Output voltage is:

$$P=\log^{-1}(2V)\text{or}$$

$$P=10^{(2V)}$$

where P is pressure in mtorr or μ bar; V is the Analog Output in volts.

Some examples follow; because of normal tolerances in the electronics, there may be minor differences in the values you observe compared to those shown:

<u>displayed pressure</u>	<u>Analog Output - volts</u>
LO	0.000
0 mTorr (μ bar) or less	0.000
10 mTorr (μ bar)	0.500
20 mTorr (μ bar)	0.651
100 mTorr (μ bar)	1.000
10 torr (mbar)	2.000
990 torr (mbar)	2.998
OFF or HI	3.000
<u>Analog Output - volts</u>	<u>pressure- mtorr (μbar)</u>
0.100	1.58
0.500	10.0
0.600	15.8
1.100	158
2.000	10,000

L. Serial Interface

The serial port gives pressure readings when requested by the RS-232 terminal. The interface is standard RS-232 format; 9600 baud, 8-bits, no parity, 1 stop bit. The interface is through the DB15 accessory connector.

pin 7 is Tx (signal from terminal to the 924A)
 pin 8 is Rx (response from the 924A to the terminal)
 pin 9 is return (ground).

To get pressure readings, send a lower case "p" (ASCII value 112). Output is converted from the digital display, in the following format:

WXYeZ,

where *WXY* is the multiplier and *Z* is the exponent

Some examples follow:

<u>displayed pressure</u>	<u>Serial Output</u>
OFF	-99e-3
LO	-20e-3
0.0 mTorr	0.0e-3
0.8 mTorr	0.8e-3
2.8 mTorr	2.8e-3
-0.6 mTorr	-0.6e-3
-1.6 mTorr	-1.6e-3
57.1 mTorr	57.1e-3
2.34 torr	2.34e+0
135 torr	13.5e+0
470 torr	470e+0
HI	999e+0

To read the stored Set Points, send a “1” (ASCII value 49) or “2” (ASCII value 50) to read Set Point 1 or Set Point 2. Output is in the same format as for pressure readings. An added digit shows whether the Set Point is active (system pressure is lower than the set point, and the set point relay is energized); this digit is “0” when the set point is not active (set point relay is off), and is “1” when the set point is active (set point relay is on).

To read the units of measure, send a lower case “u” (ASCII value 117); this returns “torr” or “mbar” depending on the units selected.

M. Serial RS-232 Cable for a PC Computer

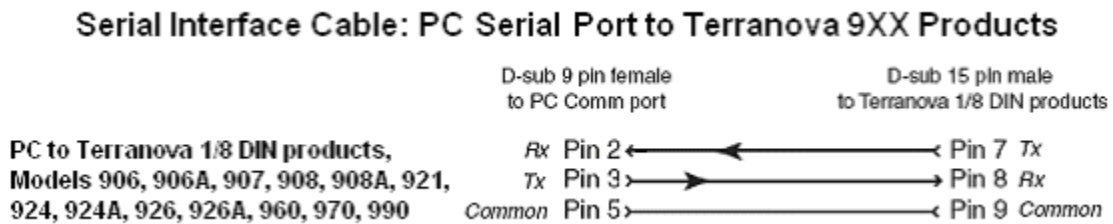


Figure 5: Serial RS-232 Cable for PC Computer

IV Maintenance

A. Changing Fuses

The controller contains two fuses. Both fuses are held in the fuse assembly that is part of the power module located on the back panel of the controller. Follow the instructions below to change a fuse.

Unplug the line cord from the power entry module at the rear of the 924A; locate the fuse block immediately below the line cord socket. Press the tab of the fuse assembly and withdraw the fuse assembly from the power module.

Turn the fuse assembly around so that the fuses are facing you. Check both fuses; replace the burnt-out fuse with a fuse of the appropriate rating (refer to **Specifications** section). Reinsert the fuse assembly into the power module; push it in until the ears click into place.

B. Schematic Diagrams

Because of the proprietary nature of our products, we do not supply schematic diagrams or software listings. If you have any problem with operation or interface to any of our products, please contact us; we will do everything we can to serve your needs.

C. Previous Model - Terranova 924



Figure 6: Rear View - Earlier Terranova 924

The picture above, Figure 5, shows the rear panel of the earlier model, the Terranova 924. The main difference is the TC gauge connector (white 4 pin Molex connector) which has been changed to a 9-pin D-sub connector on the 924A. This change was made to improve the durability of the connection to the gauge.

V Trouble shooting

If the self-test fails, run the self-test again by turning the power off and then on again. If it fails again, call Duniway Stockroom.

If fuses burn out, check to see that the proper voltage has been supplied to the power input module.

If fuses burn out repeatedly call Duniway Stockroom.

If readings at VAC or ATM seem wrong: A new Varian 531 thermocouple gauge is normally within 10 mTorr of true zero at vacuum. If recovery of factory settings (see **Operation** section) does not give readings which appear reasonable, it is possible that your gauge has become contaminated or damaged. You may try cleaning the gauge using acetone or TCE (1-1-1 trichloroethane). Be careful when using flammable solvents, so that you do not risk explosion from the flammable vapors.

You can measure the thermocouple to see if it has the correct internal resistance values. If the measured values differ from those shown, it is possible that your gauge has become damaged. These measurements must be made while the gauge is at atmospheric pressure; do not use a method which applies more than 100 mA to the pins or you will damage the fine internal wires.

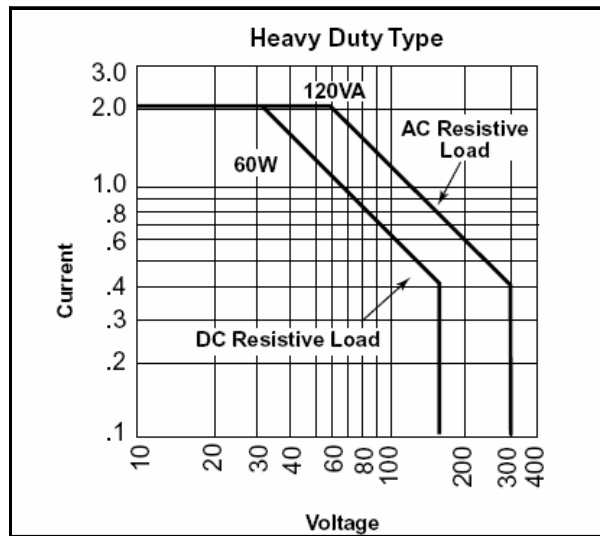
<u>between pins</u>	<u>resistance</u>
1 and 3	1.5 ohm
3 and 5	1.5 ohm
5 and 7	1.5 ohm
7 and 1	1.5 ohm
any pin and housing of gauge	1 megohm minimum

VI Application Note

Protective Circuits for Set Points

1. Rated Voltage vs. Current – Resistive Loads

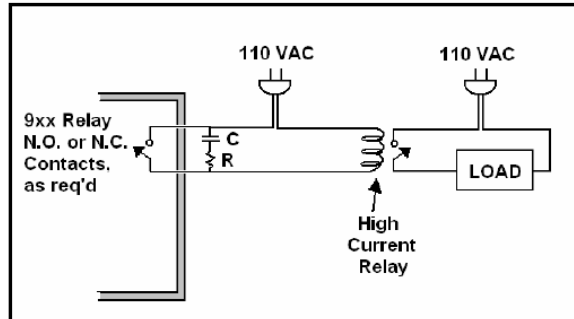
The graph below shows the relationship between the maximum voltage and current ratings specified for Heavy Duty Type AZ5 relays. These relays are used as Set Point Relays in the Terranova 9XX 1/8 DIN Vacuum Gauge Control Display products.



For resistive loads maximum current varies from 2 amps at 30 VDC (60 VAC) downward to 0.4 amps at 150 VDC (300VAC).

2. Protective Circuits for Non-Resistive Loads

For application of the Set Point relays for switching inductive or capacitive loads, it is advisable to use so-called "snubber" circuits, consisting of capacitors and resistors across the load. Such a circuit is shown in the diagram below. This circuit quenches any surges or arcs that might occur when switching such non-resistive loads. (see next page)



To calculate the values of C and R for the “snubber” circuits, the equations below give some guidance.

Snubber equations from CDE Quencharc paper:

$$C = \frac{I^2}{10} \quad R = \frac{E_o}{10I(1 + \frac{50}{E_o})}$$

where C = capacitance in uF
 I = load current in amperes prior to contact opening
 R = resistance in ohms in series with capacitor
 E_o = source voltage

For 1 amp load and 110 VAC, C and R calculate approx to:
 C=0.1 uF and R=6 ohm (use 10 ohm)

For 0.1 amp and 110...
 C=0.001 uF and R=60 ohm (use 100 ohm)

For additional information on protective circuits for set point relays, please see the Potter and Brumfield publication on the following link:
http://www.pandbrelays.com/app_pdfs/13c3311.pdf

VII Return Procedure

If you need to return the gauge controller for service, first contact Duniway Stockroom. Then pack the instrument securely. Use the original packaging if it is available. If you do not have appropriate packing materials, a commercial packing and shipping firm can provide them.

VIII Warranty

Terranova products of Duniway Stockroom Corp. are warranted to be free of defects in material and workmanship for a period of one year from the date of shipment. At our option, we will repair or replace products which prove to be defective during the warranty period. Liability under this warranty is limited to repair or replacement of the defective items. Shipping damage is excluded from the scope of this warranty. Gauge tubes of all types are excluded from this warranty.

Terranova products are warranted not to fail to execute programming instructions due to defects in materials and workmanship. If Duniway Stockroom receives notice of such defects during the warranty period, Duniway Stockroom will repair or replace firmware that does not execute its programming instruction due to such defects. Duniway Stockroom does not warrant that the operation of the firmware or hardware will be uninterrupted or error-free.

If this product is returned to Duniway Stockroom for warranty service, Buyer will pre-pay shipping charges and will pay all duties and taxes for products returned to Duniway Stockroom. Duniway Stockroom will pay for return of products to Buyer, except for products returned to a Buyer from a country other than the United States.

LIMITATION OF WARRANTY: The foregoing warranty does not apply to the defects resulting from:

- 1. Improper or inadequate maintenance by Buyer;*
- 2. Buyer-supplied interfacing;*
- 3. Unauthorized modification or misuse;*
- 4. Operation outside of the environmental specifications of the product; or*
- 5. Improper site preparation and maintenance.*

THE WARRANTY SET FORTH ABOVE IS EXCLUSIVE AND NO OTHER WARRANTY, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED. DUNIWAY S STOCKROOM DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES: The remedies provided herein are Buyer's sole and exclusive remedies. In no event will Duniway Stockroom be liable for direct, indirect, special, incidental, or consequential damages, including loss of profits, whether based on contract, tort, or any other legal theory.

DECLARATION OF CONFORMITY

We, Duniway Stockroom Corp., declare under our sole responsibility, that the following products, displaying the CE mark on the rear panel:

Model 906 Convection Gauge Controller
Model 908 Dual Capacitance Diaphragm Gauge Controller
Model 921 Cold Cathode Gauge Controller
Model 924A Thermocouple Vacuum Gauge
Model 926 Dual Convection Gauge Controller

to which this declaration relates, are in conformity with the following standards or normal documents

EMC Directive (89/336/EEC//93/68/EEC)
Electromagnetic Compatibility
Standards: EN 50081-1: 1992, EN 50082-1: 1993

Low Voltage Directive (73/23/EEC//93/68/EEC)
Electrical/Technical Safety
Standard: EN 61010-1: 1993/A2: 1995

following the provisions of the EMC directive (89/336/EEC)



August 30, 1998

Duniway Stockroom Corp.
48501 Milmont Drive
Fremont, CA 94538

by: Sherman Rutherford
Compliance Manager

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