Digital High Pressure Pirani Gauge
DHPG 210 & DHPC 210S

Operation and Maintenance Manual

Contents:

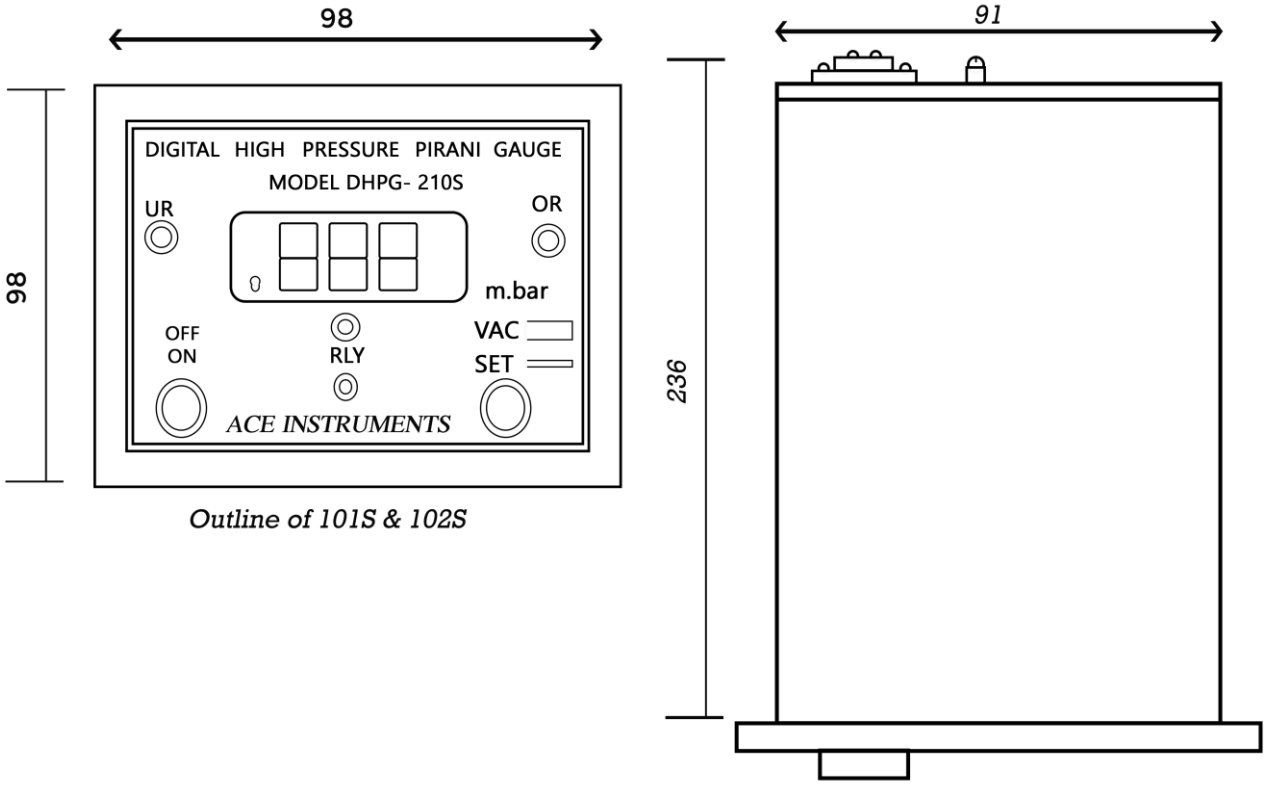
SECTION-1

1.1 INTRODUCTION

Ace Instruments Digital High Pressure Pirani Gauge model DHPG-210&210S Aare vacuum measuring instrument and controller, designed for use with thermal conductivity Type gauge head (sensor). This Provides all necessary bridge circuit and signal conditioning, analog output, analog to digital converter , digital lineariser, digital display and set point controller. Model DHPG 210 is only a measuring unit, and model DHPG 210S is a measuring unit with a set point controller. Both the models having range from 999 m.bar to 0.001 m.bar (1x103 m.bar) but better resolution can be realised from 100 m.bar to 0.0001 m.bar.

The control instrument provides necessary stabilised power supplies and bridge elements, logarithmic amplifier and comparator depends upon the model selected.

The instrument is a standard 1/4th DIN rack size having front bezel size of 98 x98 with cut-out size of 92 x 92 mm with fixing clamps. The instrument is simple to operate having only one control knob on front panel in case of model DHPG-210 and two controls knobs and one set POT in case of model DHPG-210S



Outline of 101S & 102S

The Rear panel is provided with de-mountable type CONNECTORS, for gauges head along with main cords. Fuse and analog output terminal + and – in case of Model DHPG-210 and analog output + and – and relay contacts (N.C) (COM) (N.O) in case Model dhpg-201S

The 0 to 10 Volts analog output can be used for recorder or external control signal.

1.2 APPLICATION

This instrument is having a wide range of applications, in high vacuum systems were backing vacuum systems, coating units, sputtering units, and many other applications having wide pressure range. These instruments can be used in vacuum impregnation units, epoxy mixing and casting units and similar processing equipment operating in the range of 100 to $10^{(-3)}$ m.bar.

1.3 SPECIFICATION MODEL DHPG-210

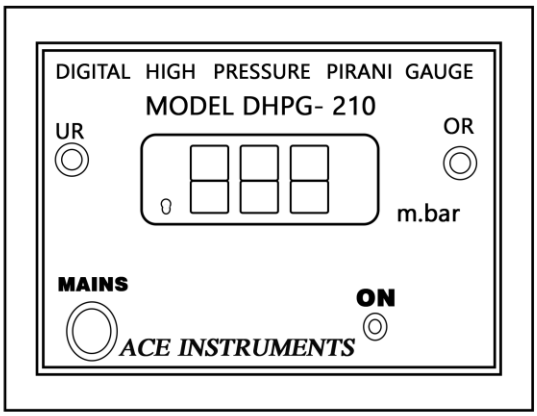
Power Requirement	230 VAC ± 10% 50Hz 10 watts fuse (approx.) 250 m. A Glass CARTIDGES 5x 20 mm	
Physical Size	Height	- 91 mm
	Width	- 91mm
	Depth	- 236 mm
	Front bezel	- 98 X 98 mm
	Thickness	- 10mm
	Cut out size	- 92 mm X 92 mm
Operating Temperature	0 to 45°C	
Pressure range	100 m.bar to 0.001 m.bar	
Gauge head (Sensor)	ACE Instruments Pirani Model HPH..33	
Analog Output	0-10 V (approx.) 10 (-3) to 1000 m.bar 0-10 volts (Non-linear) can be connected to any suitable Recorder or as a control signal with an input impedance not less than 10 K.0 hms	
Display	Three-digit LED numeric display with under Range (AT) atmosphere and (OR) over range (F.S)	

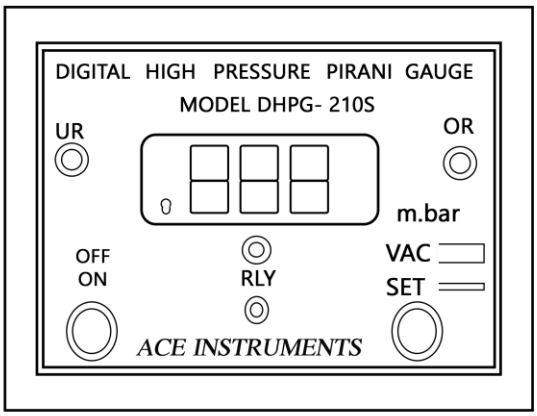
1.4 SPECIFICATION FOR MODEL DHPG-210 s (WITH SET POINT CONTROLLER)

Power Requirement	230 VAC ± 10% 50Hz 12 watts (approx.) 250 m. A Glass CARTIDGES 5x 20 mm
Physical Size	Height - 91 mm Width- 91mm Depth- 236 mm Front bezel - 98 X 98 mm Thickness - 10mm
Operating Temperature	0 to 45°C
Pressure range	100 m.bar to 0.001 m.bar
Set point Controller Range	100 m.bar to 0.001 m.bar
Analog Output	0-10V (approx.) 10(-3) to 1000 m.bar 0-10 Volts (Non-Linear) can be connected any Suitable recorder or as a control signal With an input impedance not less than 10K. ohm
Display	3-digit LED numeric display with (UR) under Range (AT) and (OR) over ranges (FS) same display used through VAC-SET spring return switch and multi turn pot to adjust set point for relay actuation

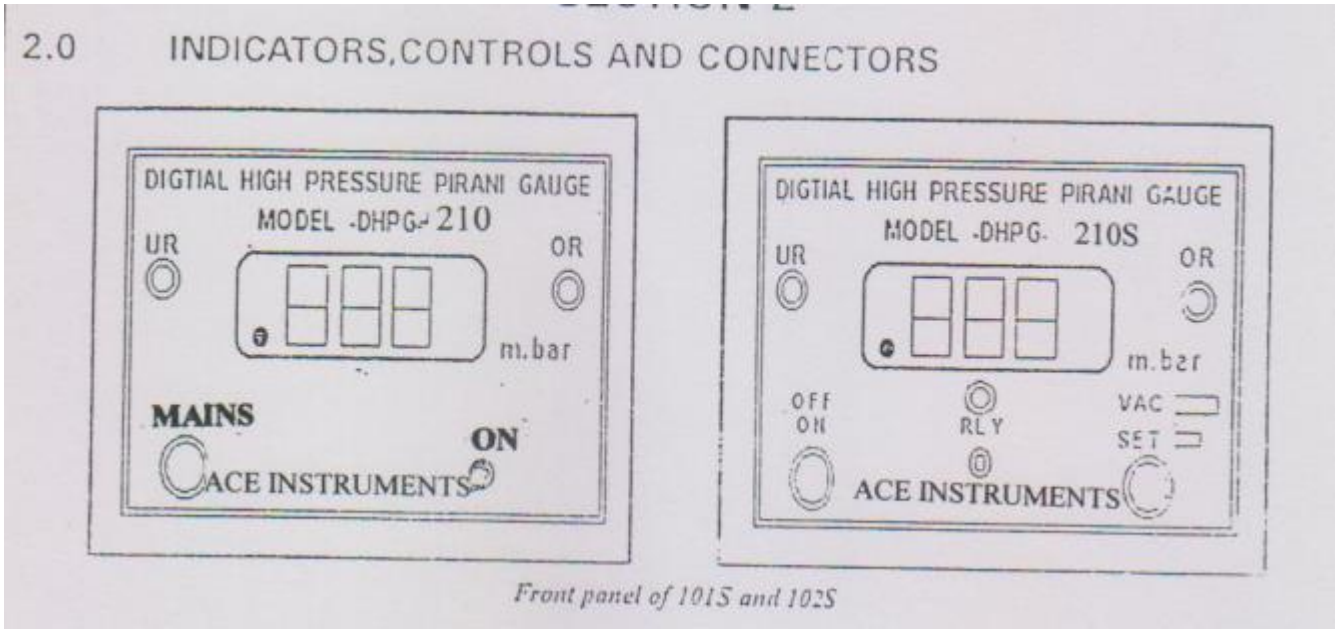
SECTION 2

2.0 INDICATORS,CONTROLS AND CONNECTORS





Front panel of 101S and 102S



2.1 Front Bezel:

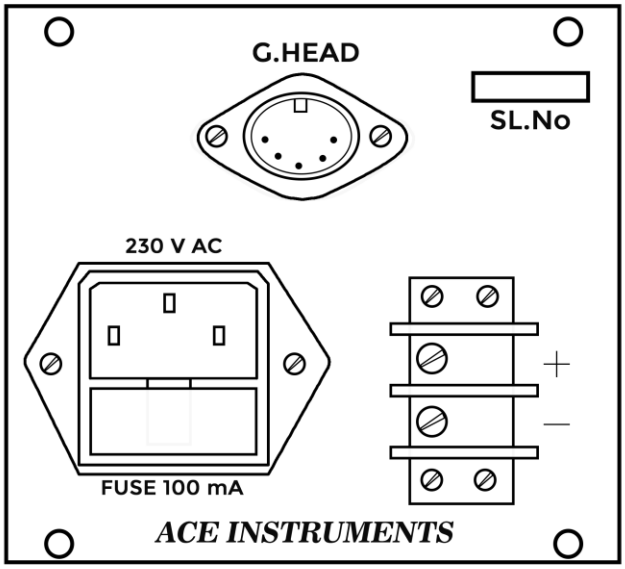
The model DHPG-210&210S have been Designed to minimise the number of controls and adjustments required to operate the unit. All the outputs and power connections are located on the back panel of the unite
(See fig 1 and 1 a)

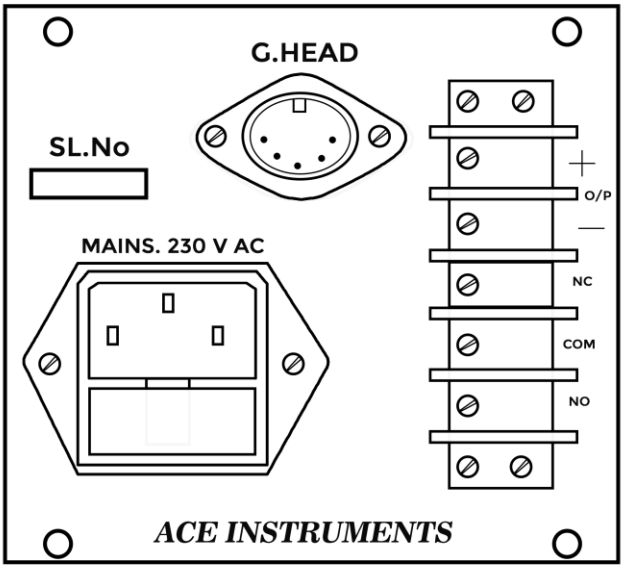
2.2 Power ON/OFF Switch

Push to ON and Push OFF turns on the

Unit, when depressed (Knob position inside) turn off the unit when depressed again (knob position outside)

2.3 VAC & SET SWITCH	Selects set point when switch is (For DHPG-210S only) depressed (Knob position inside) and reads vacuum when the knob is released (Knob position outside) through spring return switch
2.4 SET POINT ADJUSTMENT POTENTIO METER (FOR DHPG-210S ONLY)	Multi turn pot located at the centre to adjust the set point while depressing the VAC-SET Switch to set position and reading the value on digital disc
2.5 RELAY STATUS INDICATOR (RLY)	Located in between the switches,**** is up the relay is energised
2.6 U R (LED)	Located at the top left corner of the display and lights up when Gauge head is below (or) near atmospheric pressure 999 m.bar (under range)
2.7 OR (LED)	Located at top right corner of the display and lights up when the GH is above full scale (0.001 m.bar) (over range).
2.8 DISPLAY	Display pressure measurement in m.bar. First display in decimal and subsequent numeric displays range 999 m.bar to 0.001 m.bar





2.9 BACK PANEL	Provides all the out puts and input connection to 230 VAC
2.10 POWER SOCKET	Built in fuse Power socket accepts 230 VAC input through the moulded mains cord provided along with the instrument.
2.11 GAUGE HEAD	5 pin DIN Socket to connect Gauge Head (Sensor)
2.12 O/P +&-	Provides analog output 0-10 Volts.
2.13 N.C-COM-N.O.	Set point relay contacts 230 VAC 2 Amps (resistive) internally fuse protected. (Fuse 3 amps 5X20mm size)
2.14 ATM AND ZERO	Preset pots are located on PCB, Provides adjustment 999 m. Bar (ATM) and 0.001 1 X 10 (-3)m.bar (ZERO)

SECTION-3

3.0 INSTALLATION

3.1 INSPECTION

Prior to using the instrument for the first time, carefully inspect the unit for any visual signs of transport damage. Remove the top half cover by unscrewing the two-counter suck round head screws one each side of the cover and lift the cover towards top visually that might have occurred during transport. Check carefully to ensure that all the components and relays are properly seated in their sockets. Check carefully to ensure that all internal connections are in place and properly seated. Replace the cover in the same way as removed

If any damage is overserved, report and the insurance to file proper damage claim. Send copy of damage claim to ACE INSTRUMENTS Bangalore to assist in expediting replacement or repair of the instrument.

If the units fail to function properly contact our local service representative.

3.2 SUPPLY VOLTAGE

The Model DHPG-210&210S are designed to operate on 230 VAC ± 10% VAC power.

3.3 MOUNTING

The Pirani gauge may be either rack mounted, or bench operated. The units are supplied with gauge head having two-meter cable length. When mounting the units always ensure that sufficient ventilation is provided so that ambient temperature of the unit does not exceed 45 Deg C.

3.4 GAUGE HEAD

The gauge head is provided with QF-10 Clamp assembly which can be welded to user's system pipeline. It is advised to mount the gauge head in vertical position keeping the opening downwards to avoid foreign matter falling into gauge head tube. After making a leak tight joint with the adapter to users' system, the gauge head can be connected to the adapter, making sure that the '0' ring with centring ring is in position, Tighten the wing hand, so that '0' ring is compressed properly.

HI-PIRANI GAUGE HEAD

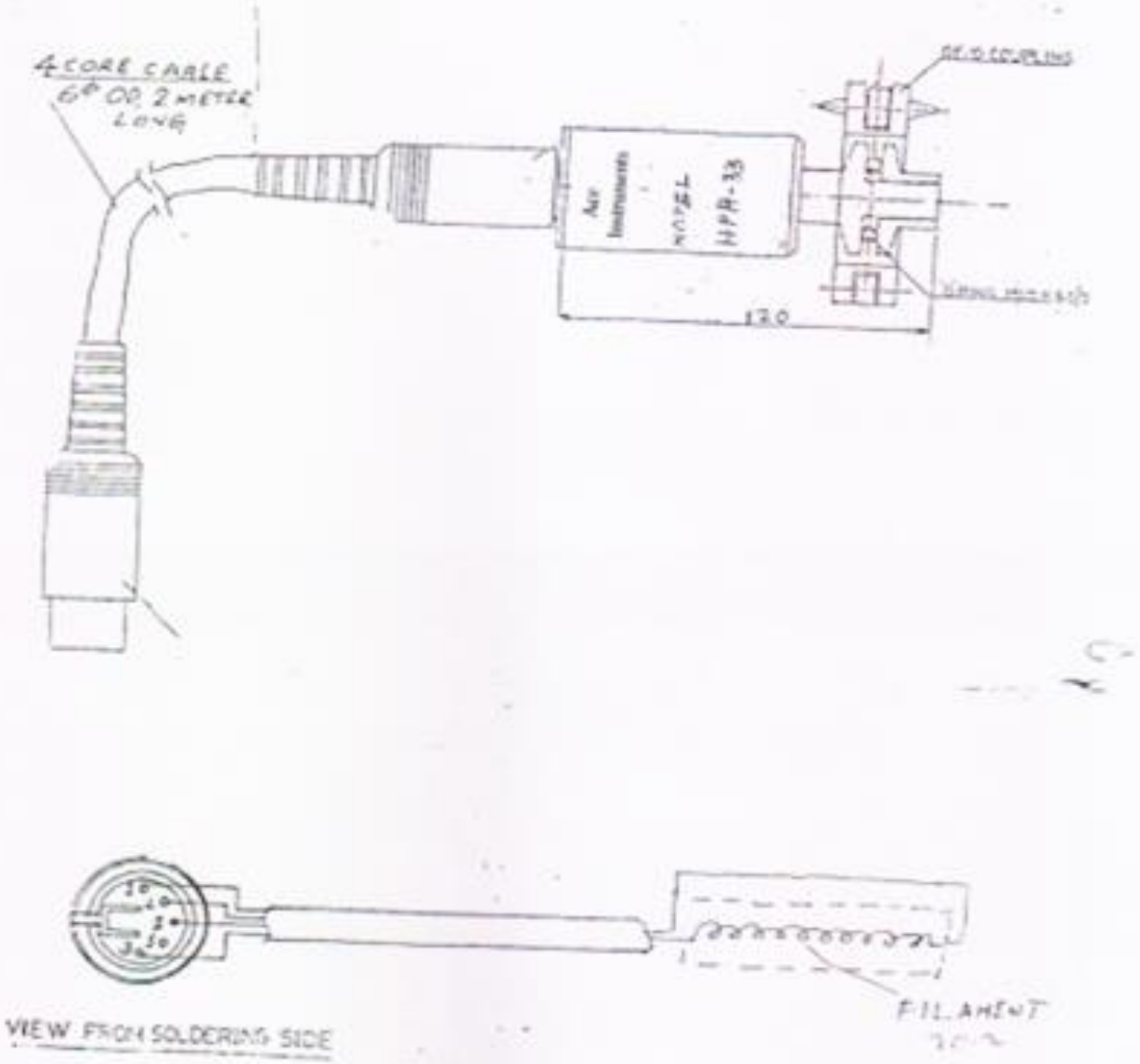


FIG – 8

QF - COUPLING ADOPTER FOR PIRANI GAUGE HEAD (KF10)

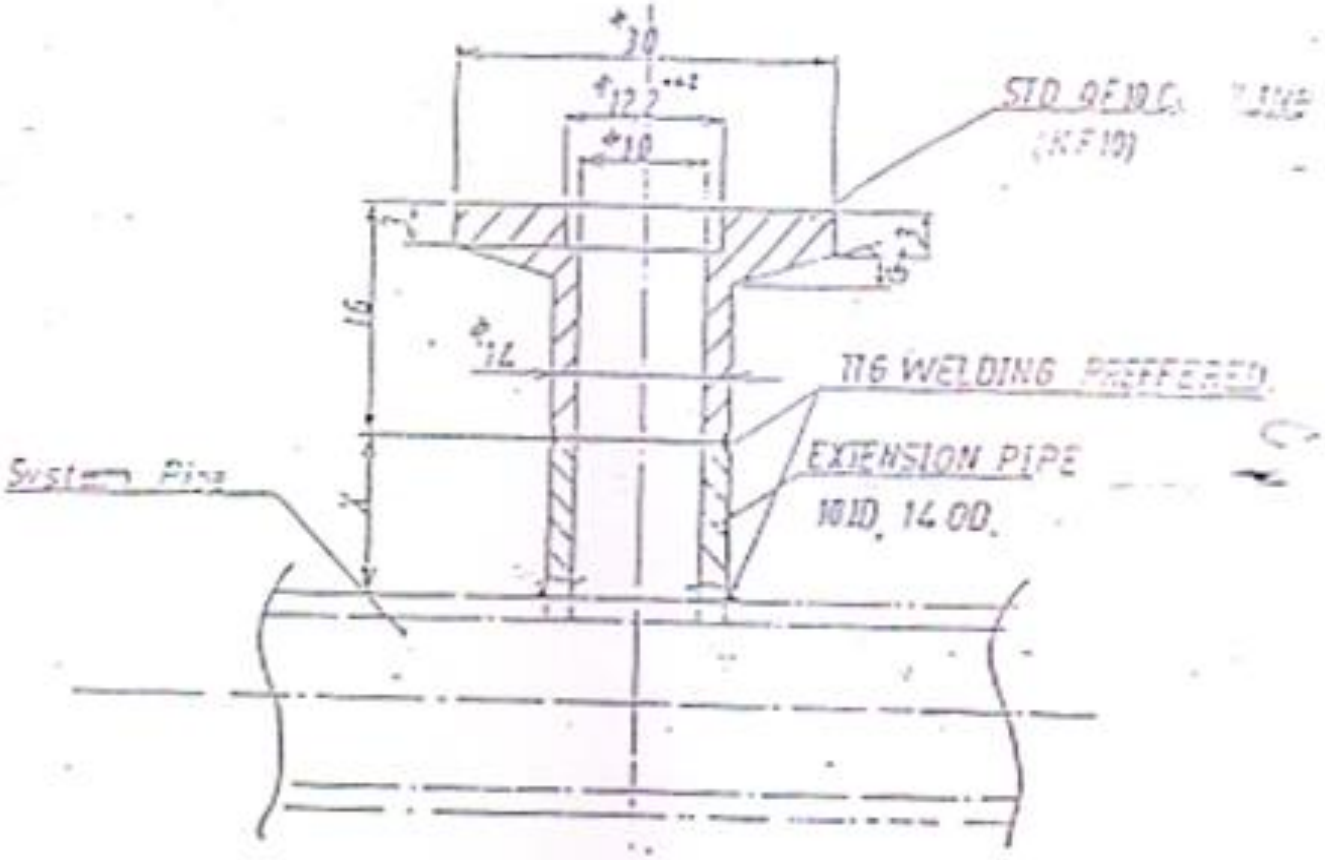


Fig. 7 A

3.5 CONTROL UNIT

Connect the power cord supplied to the unit to 230 VAC 50 Hz ± 10% supply. Use only a three-wire grounded AC receptacle. Connect gauge head 5 Pin plug to the socket provided marked Gauge head

3.6 RELAY CONNECTION

Connect proper gauge (14/0.2) flexible P.V.C. insulated copper wire for taking out contacts of either N.C-COM (or) N.O-COM as required for the control application.
When relay de-energised contact makes between N.C & COM and when relay energised N.C & COM Contact breaks and N.O & COM contacts makes.
Relay rating is 230 V.A.C. 2 Amps resistive (For inductive loads derate accordingly).
A fuse is a recommended in com line connection with a rating not exceeding 2 Amps to protect relay and P.C.B tracks from possible burnout.

SECTION 4

4.0 OPERATING INSTRUCTION

4.1 Keep the mains ON/OFF Switch in off position

4.2 Connect the 3 Pin Plug to the appropriate grounded AC 230V 50Hz Supply.

4.3 Keep the vacuum system in atmosphere where the gauge head is connected

4.4 Switch 'ON' the mains there will be momentary indication of fluctuation on digital display and the display should be indicate 999 m.bar with UR LED indications. This shows normal working condition of the instrument.

In the event of display not showing 999 m.bar, then there is some error, the same can be adjusted by adjusting the pot marked ATM on the PCB inside such that the reading shows exactly (999) m.bar with UR LED just showing up

NOTE	If any abnormality is noticed in the display or unable to adjust atmosphere (999 m.bar) (refer maintenance and troubleshooting section).

4.5 Evacuate the vacuum system to better than 1x 10(-3) m.bar. As the vacuum improves in the system, the gauge display starts from 999 m.bar reading and reaches a final reading of 0.001 m.bar indicating OR LED. This shows the vacuum is better than 0.001 m.bar and OR indicated over range.
If display does not reach 0.000m.bar with OR indication even after system vacuum establishes better than 1 x 10 (-3) m.bar with some other gauge like penning (or) B.A Now adjust zero pot slowly so that the display shows 001m.bar (ZERO). Check once again ATM and Zero positions and adjust if necessary. This completes general operation and preliminary calibration of the Pirani gauge for general purpose application in high vacuum systems.
If the gauge head is exposed other than Nitrogen or Air, a calibration correction factor must be applied as per the chart enclosed.

FOR MODEL DHPG: 210S WHERE SET POINT ADJUSTMENT IS REQUIRED THE FOLLOWING CAN BE ADAPTED

4.6 Depress VAC/SET switch to set position now the display indicates set value (approx.) where relay will be energised.

4.7 Adjust multi turn pot slowly while keeping the VAC/SET switch depressed to the required value.

4.8 While adjusting the pot if the relay energised due to the sensor is already under vacuum there can be a small change in the display due to build in hysteresis.

4.9 Repeat again the set point adjusted and operations of the relay, while varying the vacuum using the needle valve (or) isolation valve.

4.10 The inside hysteresis adjustment pot makes the normal relay energisation and de-energisation as follows.

Ready ON	-	Relay OFF (approx.)
.001 m.bar	-	.05 m.bar
.010 m.bar	-	.017 m.bar
.050 m.bar	-	.100 m.bar
.100 m.bar	-	.280 m.bar
1 m.bar	-	2 m.bar
10 m.bar	-	20 m.bar

Other reading of the customer values can be checked for the hysteresis by varying the vacuum

4.1.1 The pot marked as HYS is available internally in case if the hysteresis must be reduced than what has been provided.

Too close Hysteresis setting will make the controller to hunt and chatter the relay in actual operation

4.1 GAUGEHEAD CLEANING

When the fine sensor wire is contaminated with oil or other deposits that its emissivity or its diameter is appreciably altered, and a change of calibration will result. Cleaning with the tri chloroethylene, Toluene or Acetone is possible. Keep the gauge head upright position and clamp it in suitable place. Pour slowly through the opening and fill completely with clean solvent. Keep it overnight and remove it next day morning completely by holding downward. Pour fresh solvent and shake it slowly and drain it

again. Dry it thoroughly and prepare for re calibration as per 4.4 to 4.5 in the same section.

SECTION-5

5.0 OPERATING PRINCIPLES

This section covers a description ON general principles of operation of the Pirani Gauge and Circuit Functions.

5.1 PRINCIPLES OF OPERATION

Change of pressure in vacuum system brings about a rise or fail in number of gas molecules present and hence a rise (or) fall in the thermal conductivity of the gas. Thus, the heat loss of constant input voltage heated filament in the system varies with the pressure.

The Pirani gauge head filament has high temperature Co-efficient of resistance. So, a slight change in system pressure brings about useful change in filament resistance resulting in an out of balance of wheat stone bridge where filament forms one of the arms. In this mode the bridges balanced at pressure less than 10^{-4} m.bar. Any increased pressure unbalances the bridge and results in pressure dependent deflection in the meter which is calibrated in terms of m.bar. The Pirani gauge head indicated the total pressure if combined gases and condensable vapours in the system as the heated wire can lose heat to both gas and vapour molecules.

5.2 CONSTANT TEMPERATURE MODE

The electrically heated filament is an arm of a self-balancing wheat stone bridge circuit. An automatic control amplifier corrects bridge voltage automatically, so that the filament temperature is kept constant around 120 Deg.C throughout the whole measuring range. Thus, the required bridge voltage (which varies depend upon the pressure at the sensor head filament) is a measure of the pressure which after proper conditioning and calibration displayed on a digital meter.

5.3 GAUGE OPERATION

The Pirani gauge with gauge head operate as follows. (Ref Circuit diagram enclosed)

When the Pirani gauge is connected to power supply, the 230 VAC is given to primary of transformer (T) through fuse (F) and main ON/OFF switch (SW1) located on front panel.

The output from secondary's of the transformer is rectified and filtered and fed to regulator circuit to generate + 18 Volts, -12 volts and +5 volts and -5 along with regulated D.C nominal voltage of 26 Volts, to operate automatic bridge balancing circuit and signal conditioning operational amplifier circuits.

SECTION-6

6.0 CIRCUIT DESCRIPTION

When the gauge is switched on the power supplies +26 volts unregulated (varies +21 to 34 volts) + 18 Volts, -12.0 volts and +5 volts regulated power supplies are available.

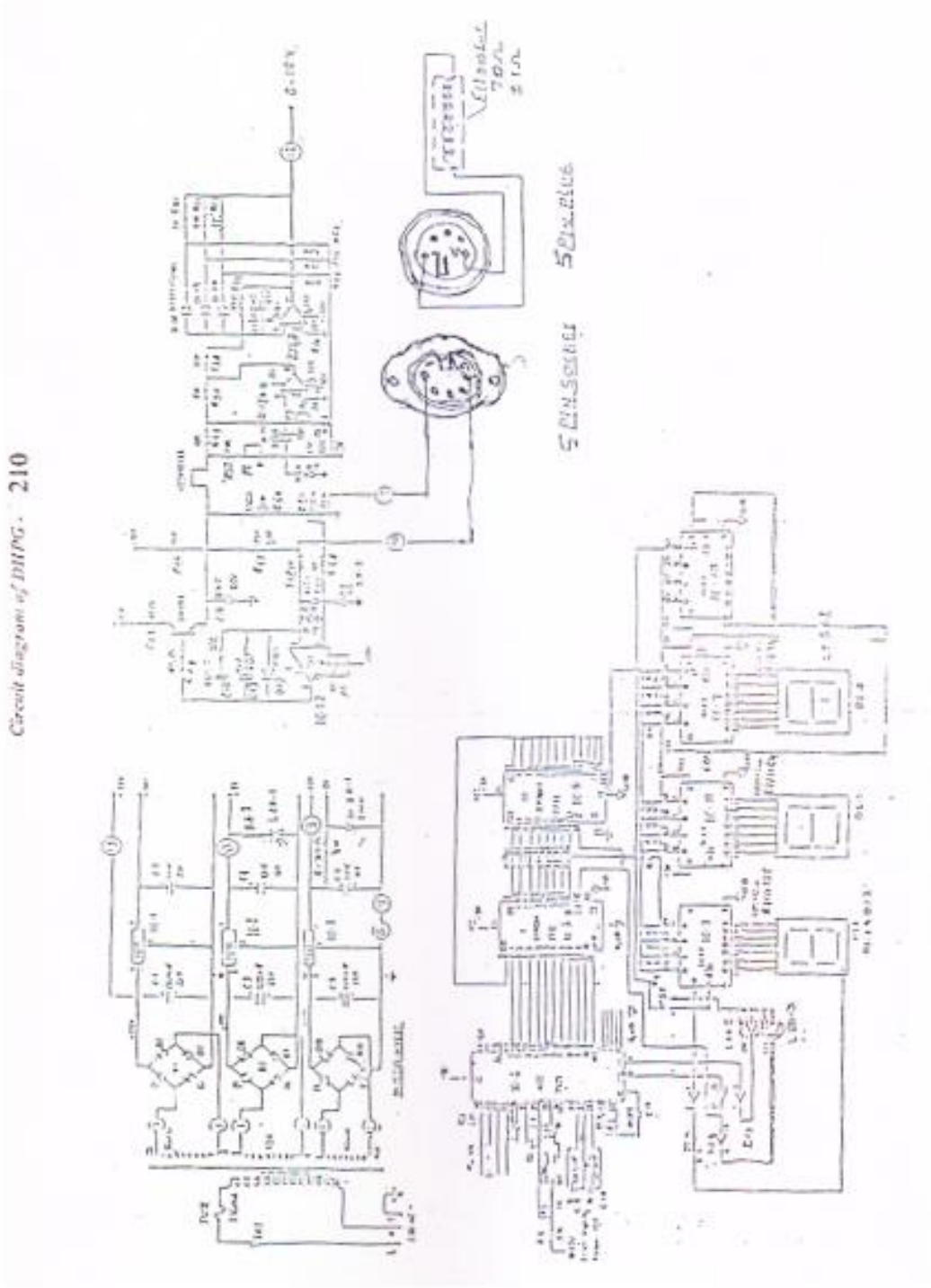
When gauge head is connected into the rear socket and the power supplies are available. The wheat stone bridge configuration completes through R1 (550 Ohm) R2 (550 Ohm) R3 (150 Ohm) and sensor filament 72 Ohm, and to start up the auto balancing, a small amount of voltage derived from +18 volts through Rs (39K) is fed to bridge circuit. This generated differential voltage across the input terminal of 1C-12(741), which produces an output voltage at the base of the transistor 2 N 1711 through R 2 (100 Ohm), which in turn controls the bridge voltage to balance the bridge automatically. As the gauge head is turn controls the bridge voltage to balance the bridge automatically. As the gauge head is evacuated to a higher degree of vacuum, due to thermal conductivity change with gas pressure, the filament temperature will try to rise and since it is a closed loop control the bridge voltage drops down to bring back the filament temperature. In this process the bridge voltage is highest when sensor is at atmospheric pressure and lowest when the sensor is at 10(-3) m.bar or better.

The IC13 747, (Double OPAMP Type) stage I, provides ATM 999 m.bar and zero (0.001) ($1x10^{-3}$ m.bar) adjustments for calibrations of the sensor head.

The IC 13 (747) stage II provides, signal conditioning of the non-linear signal into a logarithmic signal by means of diode-resistor network.

This stage generates an output of 0-10 volts corresponding to 999 m.bar to 0.001 m.bar which is used to drive the digital display. The signal also can be used for recorder or for external process control. The analog signal 0-10

Volts after necessary voltage dividers is fed to an analog digital converter type ADC 7109.
The A.D.C 7109 Converts analog input voltage into 12-bit binary outputs and the address inputs to the EPROM (erasable programmable read only memory). The programmed 32-bit EPROMS drive 7447 decoders and display drivers
7447 in association with 7404 drives seven segment displays, range LED's and decimal point.



CIRCUIT DESCRIPTION FOR MODEL DHPG-210S

An additional set point controller circuit comprising of operational amplifier IC-14 a & b (747) dual op. amp for voltage gain and comparator purpose in association with VAC/SET switch and multi turn pot is used.
The 0-10 Volts analog signal available corresponding to 999 m.bar to 0.001 m.bar is fed to one of inputs of the comparator IC-14/b. A reference voltage corresponding to signal is generated through set point and conditioned through IC-14a and fed to the other input of the comparator IC-14b. The error signal makes the comparator IC-14b output to swing positive high or negative high. When positive the forward biases transistor SL 100, conducts to saturation and switches relay on. The positive feedback provided through diode D102, and POT (P 102) makes it possible to generate hysteresis to switch 'ON' relay at a lower vacuum level & OFF relay at a high vacuum level as compared to above. This avoids nonsense tripping or chattering of the relay with the external process events.

0 to 10 V Algorithmic Output

	125 Ohms
Readings(mbar)	Volts
0.001	0.01
0.003	0.5
0.006	1V
0.009	1.5V
0.014	2V
0.019	2.5V
0.028	3V
0.046	3.5V
0.086	4V
0.21	4.5V
0.37	5V
0.58	5.5V
1	6V
2	6.5V
3	7V
4	7.5V
6	8V
10	8.5V
21	9V
250	9.5V
410	9.6V
510	9.7V
610	9.8V
750	9.9V
870	10V
999	10.1V
UR<---999	10.33V

Note : For connectivity with PLC, please check the above Algorithm if compatible at the PLC end

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