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# Interfacing of SIP Controller with Micro Controller

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*Abstract* – **SIP power Supplies being used are linear type. The existing design is overrated, display is LED based and communication interface is not available. An effort is made to optimize the design of power circuit and also interface the supply with microcontroller. By doing this, on one side, considerable reduction in weight and volume of the supply is achieved and on the other side, it is now possible to access the power supply remotely through PC with convenience and speed, over current trip capability is built-in and the display is made intelligent, LCD type. It is now possible to simultaneously display voltage and pressure/current in the whole range without any manual switching and also over current trip status.**

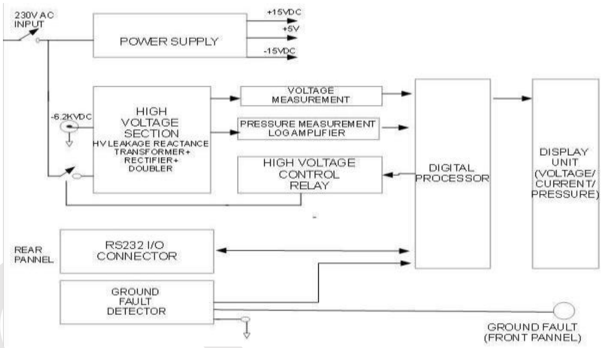
*Keywords*– **Sputter Ion Pump (SIP), LCD, LED.**

## I. INTRODUCTION

Power supply, which is used to energize the ion pump, has to be able to meet a fairly wide range of load variation. While operating at a high pressure, since the characteristics of the pump is such, that a glow discharge appears between anode and cathode, the pump draws rather heavy current from the supply. In this condition, the voltage across the pump is very low or near to zero. At that time the current is high which is called **short circuit current.** The actual value of this current is dependent on the intensity of the electric discharge and is also governed by the geometry and the capacity of the pump. As the pumping action get under way, the discharge intensity comes down, thereby reducing the current that has to be handled by the power supply. With the change in pressure there is the proportional change in the current. And from this current the pressure generated can be inferred. As the current decreases the voltage across the pump increases and when the pressure gets to order of $10^{-8}$ torr, the voltage ranges to its maximum value (negative).

In order to meet the demand of the power supply, the design should be developed to handle maximum open circuit voltage and minimum short circuit current depending on the pump size selected. The voltage across the secondary side of the high voltage transformer is rectified by a high voltage bridge and then filtered by the capacitor filter. The current drawn by the pump develops voltage across various shunts for different current range. This voltage is buffered, amplified with the help of ADC and micro controller and can be displayed on LCD. The dc high voltage is sensed by the log amplifier and then further by voltage divider and can be displayed on the LCD.

## II. SIP CONTROLLER




Main controller consist of the following parts

- High voltage power supply (that includes HV leakage reactance transformer and high voltage full wave doubler).
- Auxiliary Power supply for circuit operation
- Voltage & Current Signal conditioning circuit
- Microcontroller based digital display

It shows that the circuit is a combination of linear High Voltage Section and microcontroller based interfacing section. Mains power is fed through a fuse and MCB to a high voltage leakage reactance transformer. The secondary of this transformer generates 2200V rms. This voltage is then rectified and doubled by means of a full wave doubler circuit to -6.2 kVDC. The leakage reactance transformer limits the short circuit current of the transformer to 520mA. This is required because the electrodes cathode and anode are very close to each other inside the pump.

The high voltage supply has poor regulation characteristic which is also the requirement from load the SIP side. The high voltage thus generated is connected to a SIP feedthrough through a current limiting high power resistor of value 33 Ω, 50 Watt. When high voltage is fed to the cathode, there may be arcing between the electrodes due to which doubler capacitors may discharge and charge a number of times with short duration and high peak values of current. This may damage the doubler circuit. To prevent this, the high power resistor is used. The pump body is grounded.

A bleeder of value approx. 60 MΩ is connected across the doubler to discharge the high voltage within 10

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seconds when the controller is switched off. In controller on condition, it serves as voltage divider circuit for voltage measurement purpose. The voltage signal derived is -6.2 V corresponding to -6.2 kVDC. This signal is buffered and isolated by means of isolation amplifier ISO102 before being sent to ADC.

The current drawn by SIP is sensed across a resistor on its way from positive high voltage terminal to negative high voltage terminal via ground and the pump. A 1/10000th portion of this current is diverted to a log amplifier circuit. This attenuation is done to match the input current range of the log amplifier. The purpose of using a log amplifier is to compress the current range, which spans in six decades, to within 0-10 V.

This circuit gives log output 0V-6V corresponding to the input current range of 50 µA to 50 pA which in turn corresponds to SIP current of 500 mA to 500 nA. Since SIP current is proportional to pressure it sees, therefore, this logarithmic output is also a measure of pressure.

The current drawn by the sputter ion pump is nearly proportion to pressure. For this the equation used for calculation of pressure is:

**P = (Kx1)/ (SxV)**

**Where P= pressure in mbar**

**K= constant of the pump**

**I= the cureent in ampere**

**S= is the pumping speed oF SIP**

**V= voltage in kilovolts**

This voltage and pressure signals are then fed to the microcontroller section for processing through a digital processor for display purpose on LCD display module. Pressure signal is also converted back to current signal by means of look up table for display purpose.

## III. SOFTWARE USED

- KEIL µVISION 4.0
- OR-CAD
- PROTEUS 8.0

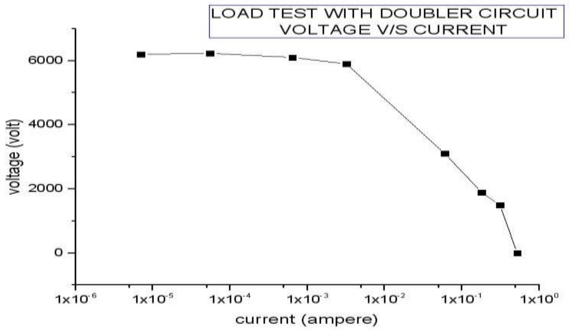
## IV. COMPARISION BETWEEN IDEAL SUPPLY AND SIP CONTROLLER

| Load current | Input to log amplifier | Log output voltage | Pressure |
|---|---|---|---|
| 100mA | 10uA | 1V | $10^{-5}$ |
| 10mA | 1uA | 2V | $10^{-6}$ |
| 1mA | 100nA | 3V | $10^{-7}$ |
| 100uA | 10nA | 4V | $10^{-8}$ |
| 10uA | 1nA | 5V | $10^{-9}$ |
| 1uA | 100pA | 6V | $10^{-10}$ |
| 100nA | 10pA | 7V | Under range |

Ideal pressure as per the load

| Load current | Log output voltage(volt) | Attenuated log output voltage for V-I conversion in uC | Voltage displayed on LCD in kilovolts | Current displayed on LCD | Pressure displayed on LCD in mbar |
|---|---|---|---|---|---|
| short | 0 | 0 | 0 | 500mA | 3.60E-005 |
| 300mA | 1.5 | 0.64 | 1.5 | 300mA | 3.40E-005 |
| 200mA | 1.9 | 0.86 | 1.9 | 200mA | 1.50E-005 |
| 60mA | 3 | 1.24 | 3 | 60mA | 5.80E-006 |
| 3mA | 6.2 | 2.51 | 6.2 | 3mA | 3.10E-007 |
| 650uA | 6.3 | 3.22 | 6.3 | 650uA | 6.00E-008 |
| 60uA | 6.4 | 1.3 | 6.4 | 60uA | 5.20E-009 |
| 7uA | 6.4 | 5 | 6.4 | 7uA | 8.00E-010 |
| Open | 6.4 | 5.74 | 6.4 | 2uA | 1.50E-010 |

## V. RESULT




## VI. CONCLUSION

A SIP power supply is interfaced with microcontroller to display voltage current/pressure and to control its working. The output of the supply is 6.2 kilovolt and 520 mili-ampere and is sufficient to energies the SIP to generate a pressure of $10^{-11}$ mbar. The Sip comes into the picture when we have ultra-high vacuum that have the range of $10^{-3}$ to $10^{-11}$ mbar.

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