CHAPTER II

REGULATOR SYSTEM

2.1 Introduction

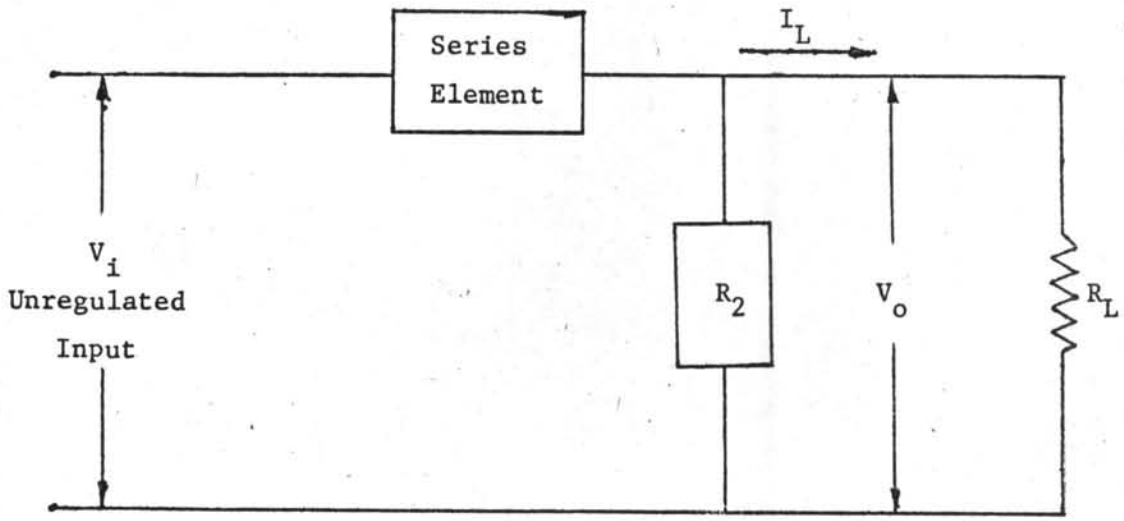
In general, a power supply is a circuit which transforms elec trical input power, either ac or dc into dc output power. This distinguishes power supplies from other electronic power sources which are dealt with elsewhere under the following heading, dc to ac inverter, dc to dc converters, and static inverters. The term power supply is commonly used when refers to an regulation power supply.

The basic equivalent circuits of series and shunt regulators [7] are shown in Fig. 2.1. It is evident from the circuit of Fig 2.1(a) that the output voltage v_o can be stabilised against variations of the input voltage v_i or the load current I_L by making compensatory adjustments to the values in the series element.

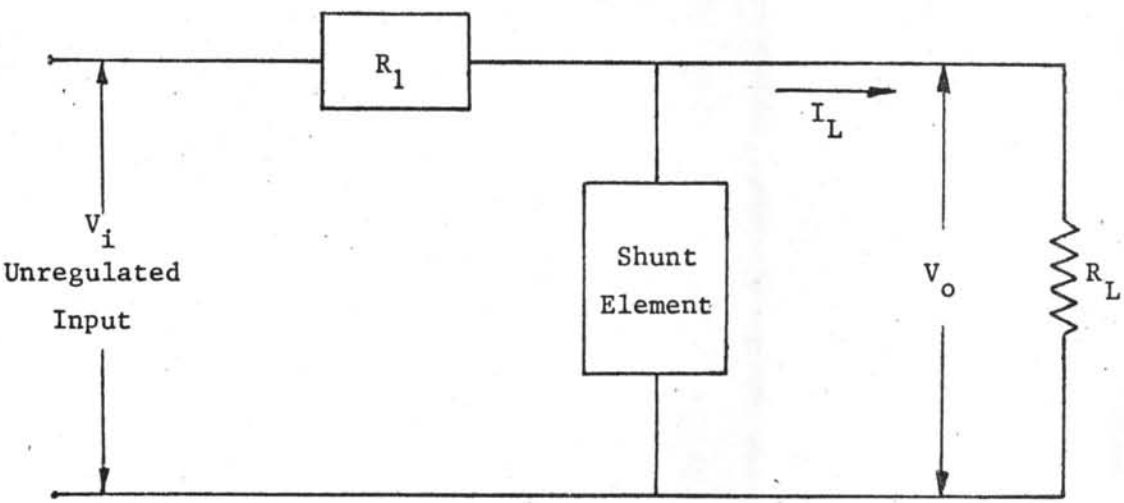
The regulator with shown in Fig 2.1(b), it consists of a series dropper resistor R_1 and a shunt element. The stabiliser element in its simplest form is a voltage regulator diode (zener diode).

These two types of regulators, are very well-known and frequently used by many designers. The principle block diagram of a series regulator is illustrate in Fig 2.2

From the block diagram shown in Fig 2.2, it can be seen that the output voltage is compared with a precision voltage reference, if these two voltage are different, then the comparator will cause the increasing or decreasing the impedance of the series control transistor to maintain



(a) Series Regulator Circuit



(b) Shunt Regulator Circuit

Fig. 2.1 Basic Circuits of Series and Shunt Regulators.

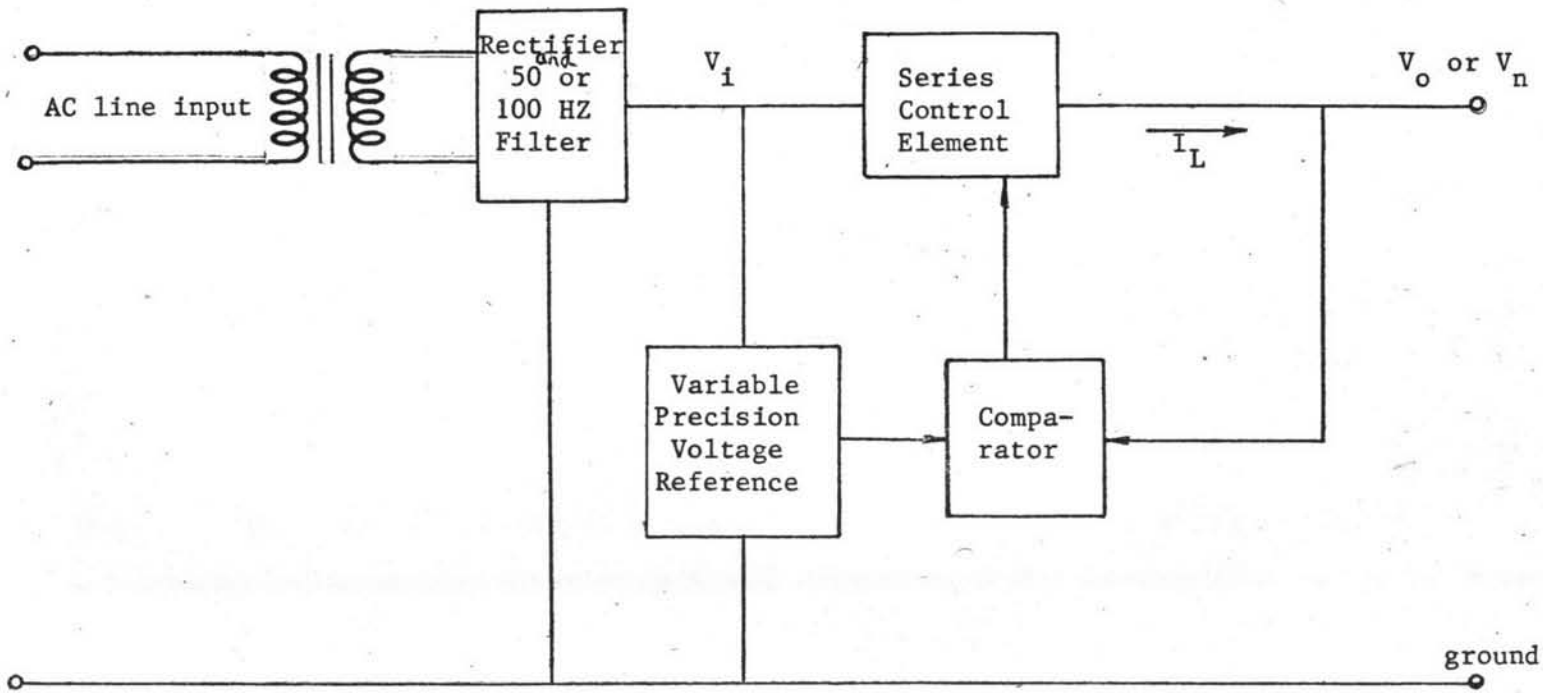


Fig. 2.2 Series Regulator System

the output voltage. To allow the series control element to work properly, the unregulated dc voltage from the transformer and the rectifier assembly must always be higher than the output voltage.

For example, if the power supply is varied between 0 to v_o volts at I_L amperes then the unregulated dc supply must be higher than v_o volts, say v_i volts. When the output voltage has changed to v_n volts, the voltage drop across the series control element will be $v_i - v_n$ volts. Therefore, the power dissipation loss is $(v_i - v_n)\ I_L$ watts. This loss may be reduced when the value v_i is closed to v_n. This may be done by tapping the transformer, but it is impractically to adjust the various tapped positions on the transformer. Morever, a sufficiently large transformer and heat sink are required for this series control transistor so it takes quite a space for this unit. Normally, the efficiency of this type of dc power supply is about 30 %

To achieve the higest efficiency, a switching regulator dc power supply is introduced and will be describedin more detail in the next section.

2.2 Switching regulator

A switching regulator dc power supply may be named "Transformerless power supply"[2] because there is no power transformer but the isolation between the main input supply and the regulated output is by means of a small high frequency ferrite transformer. A method of design and construction of a high frequency transformer will be discussed in chapter 4. In such a system, a pulse transformer or an optical couple must be required to isolate the ac line input against the dc output. Only an optical couple device is used in this research and the circuit diagram will be given

in section 5.7.5

Consequently, switching regulators shine with the highest efficiency, coolest operation and smallest size per watt in a regulated power supply.

2.3 Basic Operation

Consider the block diagram of a switching regulator dc power supply illustrated in Fig. 2.3. After high frequency filtering, the ac main input voltage is converted into a dc voltage by a bridge rectifier and then passes through a smoothing circuit. This dc voltage is then applied to a pair of switching transistors which are driven at 20 KHz by the control circuit. The square wave output resulted from the high frequency unit is passed to a small high frequency transformer and then rectified by a smoothing high frequency filter to obtain the regulated dc power output. This dc voltage is then fedback to the optical couple for isolating and also comparing with a reference voltage. The different output will be fed into the control circuit which adjusts the width of the pulse in a high frequency switching unit so as to maintain the constant output voltage.

2.4 Problems in Practical Design

The research will emphasize on a low cost and a simple method of design . This can be extended to have the power output up to 1 Kilowatt with a highest efficiency, small size and weight.

William P. Steele [11] has developed the switching regulator dc power supply with rather so complicated circuits. Furthermore, some troubles can happen such as the ripple factor, radio noise inteference because most of the components in the supply are not isolated from the power line.

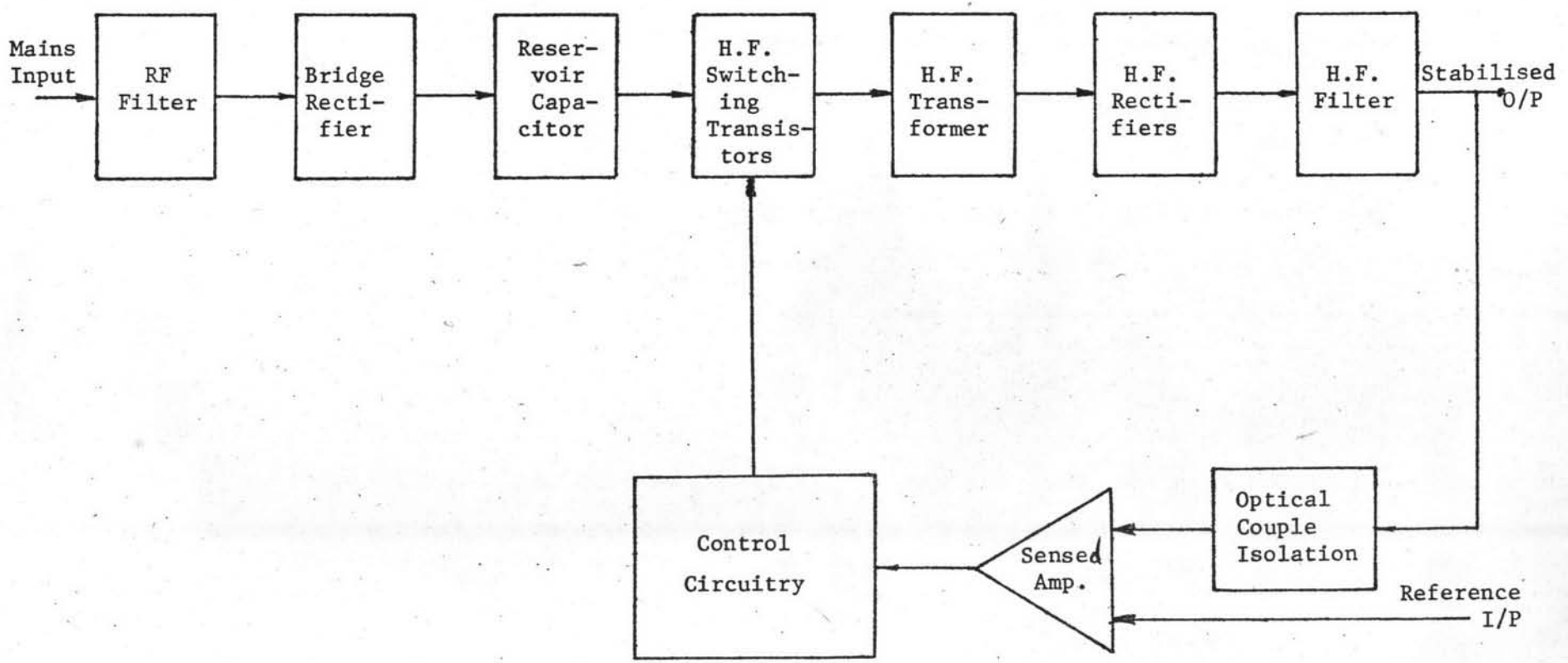


Fig. 2.3 Block Diagram of a Switching Voltage Regulator.

M.S.Dudley[2] introduced a method of using a pulse transformer in the feedback path to isolate the main line from the output. However, this system is very difficult to design and to obtain a perfect pulse waveform from a pulse transformer. The magnetic material which is used in a pulse transformer is so expensive, and is also difficult to purchase in the local market.

In this research, the attempt has been made to avoid all of those problems. A control unit in the feedback path will be designed with low cost components. In particular, an optocouple is being considered in this system to isolate the main line and the output.