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Linear PWM Strategy for SMPS

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***Abstract*: - A switched-mode power supply (switching-mode power supply or SMPS) is an electronic Power supply incorporates a switching regulator in order to be highly efficient in the conversion of electrical power. In SMPS using PWM chip, It requires hyperbolic curve of nonlinear nature of Input voltage & on time for smooth working. The desired hyperbolic curve of nonlinear nature cannot be obtained using the existing PWM chip. So sometimes it over compensates & sometimes it under compensates. This causes error in the output voltage. In this paper SMPS with linear PWM strategy is introduced.**

Keywords: Switch mode power supply, Pulse Width Modulation, Nonlinear

I. INTRODUCTION

All electronic circuits need a power supply. A device that transfers electric energy from a given source to a given load using electronic circuits is referred as power supply. Two types of DC power supply are available in the market i.e. Switched mode power supply & Linear power supply. SMPS is preferred over Linear power supply by many customers as for same power rating , SMPS is smaller, cheaper and lighter than linear power supply especially transformer. The high frequency switching transformer that is required in SMPS is smaller and lighter than the transformer that is required in linear power supply. Also the efficiency of SMPS is better than linear power supply. SMPS also have better efficiency than linear power supply. In Switch Mode Power Supply, Pulse Width Modulation technique is used in control the closing and opening switches. The on and off of the switch is important because the duty cycles of the PWM is used to regulate the DC output voltage .So the desire output voltage can be produced by generate various duty cycle. So There is compensation for changes in the input supply and output load. Then the output voltage is compared to the reference voltage which is accurately set and the error voltage given by the comparator is used by dedicated control logic to terminate the drive pulse to the main power switches at the correct instance. This will provide a very stable dc output supply if the circuit is designed accurately. In this paper Linear PWM strategy for SMPS is suggested. As for the smooth working of Switch Mode Power Supply, Pulse Width modulation Chip requires hyperbolic curve of nonlinear nature of Input voltage & on time. The desired
Hyperbolic curve of nonlinear nature using the existing PWM chip cannot obtain. So sometimes it over compensates & sometimes it under compensate. Which causes error in the DC output voltage?

II. BACKGROUND

The block diagram of S.M.P.S. shows that it is fairly complicated circuit. Shown in Fig. 1. (This configuration assumes a 50/60Hz mains input supply is used.)[1]. The ac supply drawn from the mains is rectified first, and which is then filtered by the input reservoir capacitor to produce a rough dc input supply. Due to variations in the mains this level can fluctuate widely & the capacitance on the input has to be fairly large to hold up the supply in case of a severe drop in the mains. (The supply is called a dc to dc converter When the S.M.P.S. configured to operate from any suitable dc input).The unregulated dc is given directly to the central block of the supply, the high frequency power switching section. Switching power semiconductor devices such as MOSFETs and Bipolar which are fast devices are driven on and off, and switch the input voltage across the primary of the power transformer. The frequency of drive pulses are normally fixed (20 to 200 kHz) and variable duty cycle. Hence, on the transformer secondaries a voltage pulse train of suitable magnitude and duty ratio appears. Depending upon the topology used, this voltage.

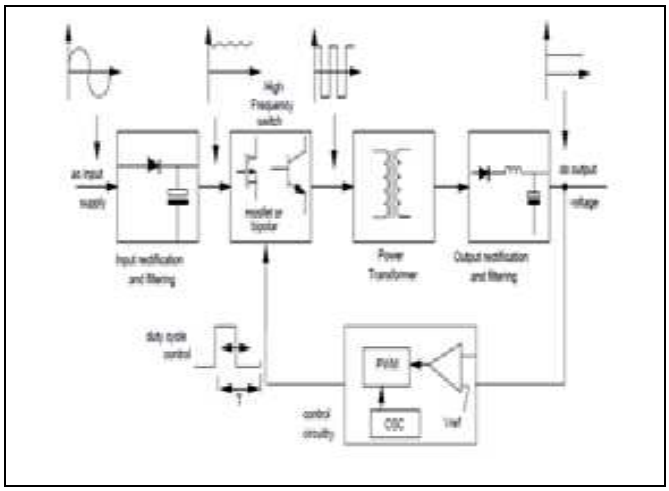

Fig.1: Basic Switch Mode Power Supply Block Diagram

Pulse train is appropriately rectified, and then smoothed by the output filter, which is either a capacitor or capacitor / inductor arrangement. To maintain efficiency, this power transfer has to be carried out with the lowest losses possible. Thus, selection of the correct power semiconductors and optimum design of the passive and magnetic components is critical. To provide a stabilised dc supply, regulation of the output is carried out by the control / feedback block. Generally, most S.M.P.S. systems worked on a fixed

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frequency pulse width modulation basis, where the duration of the on time of the drive to the power switch is varied on a cycle by cycle basis.[1] This compensates for variation in the input supply and output load. Then the output voltage is compared with the reference voltage of comparator. An error voltage obtained from comparator is used by control logic to terminate the drive pulse to the main power switches at the correct instance. In this way the Switched mode power supply works which provide efficient use of power.

III. SMPS WITH LINEAR PWM TECHNIQUE:

The Basic equation required for Switch Mode Power Supply is

$$V_o = \frac{V_i * T_{on}}{T} \qquad (3)$$

Where, V_o = Output Voltage,
V_i = Input Voltage,
T_{on}= On Time,
T = Total Time

The existing SMPS requires hyperbolic curve of nonlinear nature. But practically it is not possible to obtain the required curve. So characteristics of V_i vs. T_{on} can be plotted using the equation given below:

$$T_{on} = \frac{V_o * T}{V_i} \qquad (4)$$

The Plot of V_i Vs. T_{on} is shown below:

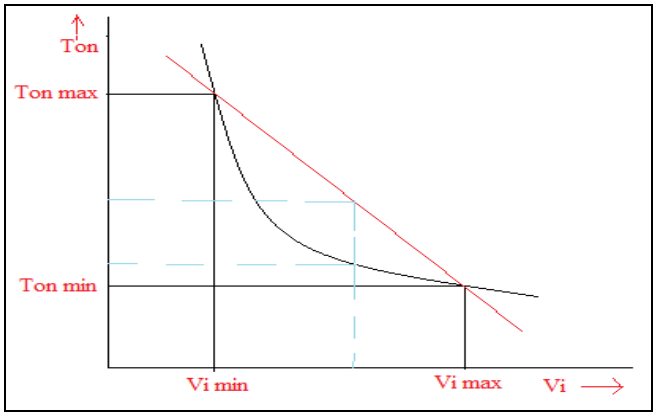

Fig.2: Plot of Vi Vs. Ton

In this the nonlinear slope is obtained practically using existing SMPS but it requires hyperbolic curve of nonlinear nature for smooth working. As by this characteristics sometimes it under compensates & sometimes overcompensates the input voltage. So there is error in output voltage. So now we employ linear PWM strategy to SMPS in Which Integrator circuit is used in place of PWM Chip. For that the considerations are,

$$Vi*Ton = Constant \qquad (5)$$

So, Now Integrate Vi Over T.

$$V_{ramp} = \frac{1}{\tau}\int_0^T V_i \, dt \qquad (6)$$

Where,

τ = Time Constant of integrator

So,

$$V_{ramp} = \frac{V_i * t}{\tau} \qquad (7)$$

Now, the linear characteristics can be plotted as shown below. By virtue of which when the input voltage is compensated & the correct output voltage can be obtained.

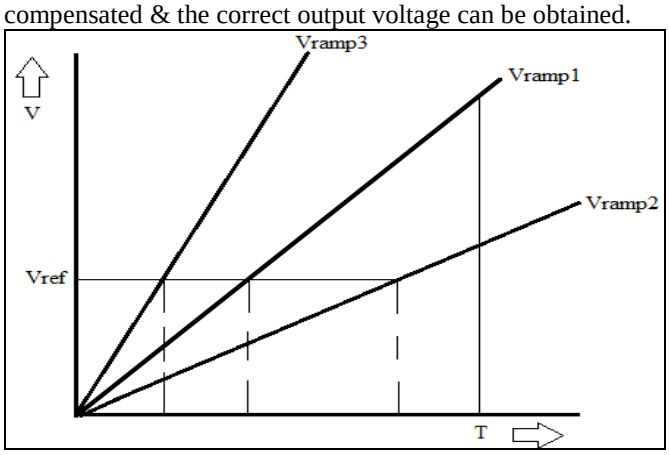

Fig.3: Plot of T Versus Vo.

So using this technique, the efficiency of SMPS can be improved.

IV. SWITCH DRIVE CIRCUIT

In the switch drive circuit the clock cycle is given to the regulator circuit via and gate for the switching. During the off time of clock cycle all the transistors are on i.e. conducts. So the input is applied to the inductor L1 & the power is delivered at the output. At the same time current builds up across the inductor. But when there is on time of clock cycle all the transistors will turned off. So the voltage across the inductor reverses and freewheel diode becomes forward biased. This allows the energy stored in the inductor to be delivered to the output.

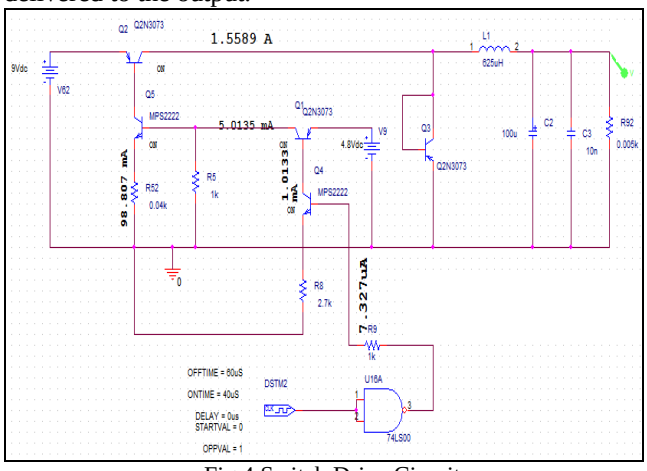

Fig.4 Switch Drive Circuit

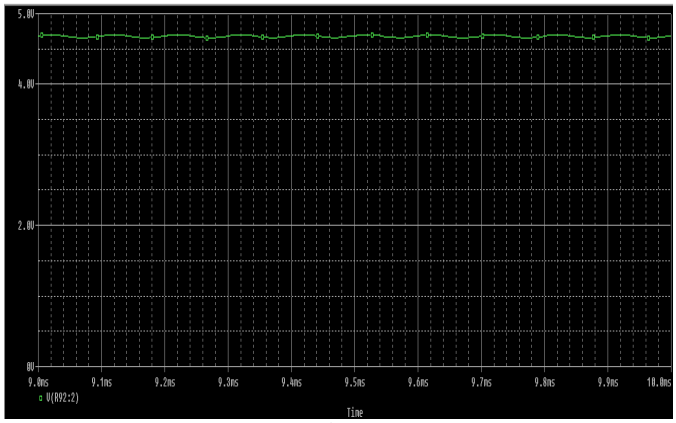

Fig. 5: DC Output of Switch Drive circuit

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This continuous current is then smoothed by output capacitor. So the smoothed DC output with very less ripples is obtained which is given to the SMPS circuit using integrator. In this way Switch drive circuit works. The DC output of Switch drive circuit with very less ripples is shown in fig.

V. DESIGN OF SMPS USING INTEGRATOR

The SMPS circuit using integrator in place of PWM chip is shown in fig.5. The integrator circuit is provided with switch & clock cycle for switching purposes. When the scaled input is provided to the circuit, during off time the switch is open & capacitor charges & ramp waveform is obtained as output of integrator. But during on time of clock cycle switch is closed & immediately the discharging of capacitor takes place. So the charging & discharging of capacitor occurs. The output of integrator is compared with some reference voltage. This reference voltage will depends upon the load. At the comparator the output of integrator is compared with the reference voltage & When the ramp Waveform crosses the reference voltage the output of comparator is one. Otherwise zero. So for getting the exact on time, the output of comparator is ex-ored with the clock cycle.

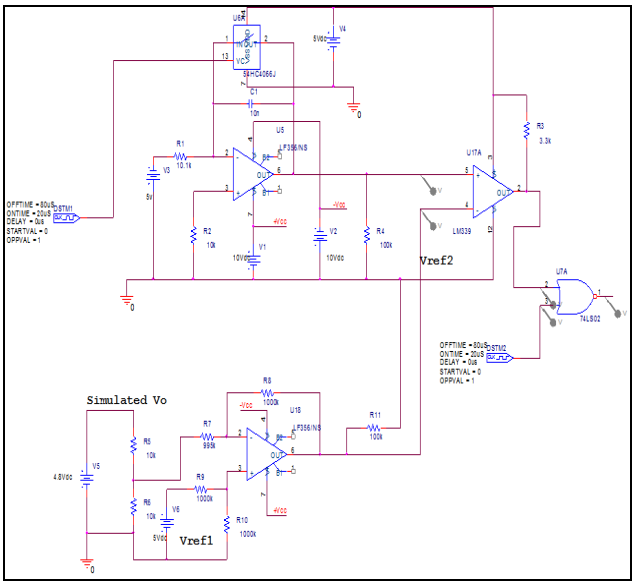

Fig6:Design of SMPS using Integrator circuit

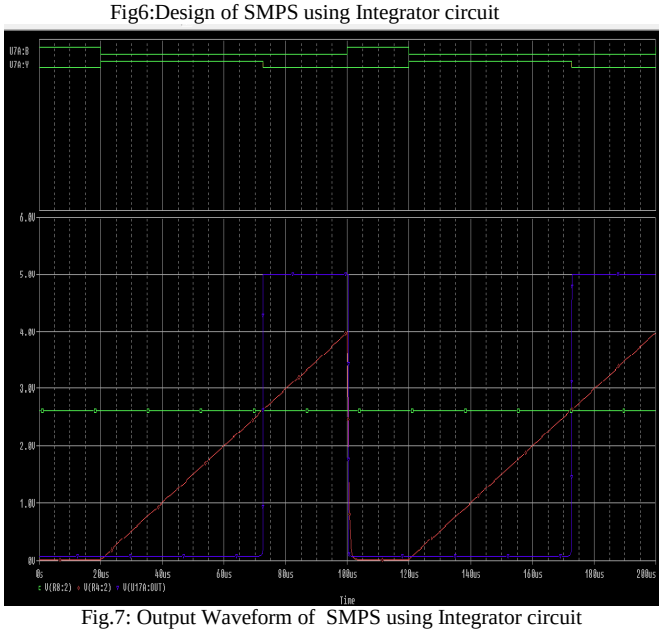

Fig.7: Output Waveform of SMPS using Integrator circuit

In the simulation waveform shown in fig.6 when the input is given to the integrator. During on time of clock cycle there is no output of the integrator as the switch is closed. While during off time, the switch is open & capacitor charges. Due to which ramp wave is obtained as output of integrator. Now this output of integrator is compared with the reference voltage which is set according to the load. Now as perfect on time for compensation is needed the needed for ramp wave to cross the reference voltage level is required. So the output of comparator is ex-ored with the clock cycle exact on time for compensation can be calculated. In this way the SMPS using linear PWM Strategy works.

VI CONCLUSION

This paper presents the new Linear PWM strategy for SMPS. Due to the use of this strategy the compensation takes place will be exact. So ultimately by using this technique the efficiency of the SMPS can be increased to great extent. So the ultimate goal of efficient use electrical power can be achieved.

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