Study and analysis of THD & Power factor in Single phase Inverter with Flyback Thyristor Converter

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Abstract—This paper presents a single phase Flyback DC-DC Buck-boost converter using Thyristor as a switch. Flyback mechanism is used to store, transfer energy to the secondary and at the same time to transfer the gate signal from the primary side to secondary side with minimum delay. To evaluate the performance of the thyristor in a Flyback converter, and converter with filter is constructed. This converter is used to study the power factor and total harmonic distortion in both the circuits. The performance of the circuit can be evaluated by the results presented in this work.

Keywords-Flyback converter; THD; DC-DC converter; Power factor;Thyristor;

I. INTRODUCTION

The most essential device required in all the electronic applications is the Power supply unit. The requirement is to design the compact converters and inverters. Flyback converters widely used in power converters and inverters because of their excellent performance of multi-output applications. For low power applications flyback converter is more attractive than the buck, boost and buck-boost converters. Flyback is the most versatile topologies, it allows user to create one or more outputs and also some of them may be opposite in polarity. The main difficulty in flyback is the control of the average input current when it operates in continuous-conduction mode (CCM). When flyback converter operates in discontinuous-conduction mode (DCM), a unity power factor can be achieved by using a simple constant on-time control. [1-5]

Harmonics are the major concern in power systems, due to effect on loads and on the power distribution systems. Harmonics increases losses in the power systems, it leads to excessive heating in the motors, and it creates EMI noises which will interference with power electronic circuits. An electrical system will supply power to load by delivering current at the fundamental frequency, only fundamental frequency current/voltage can provide main power, current/voltage delivered at harmonic frequencies do not contribute any real power to the load, instead these harmonic voltage/current creates losses in the system. The power converters and inverters are used to drive linear and non linear loads like motors and generators, the generation of harmonics at the output of the inverter system is very high. The percentage of harmonics in an AC circuit output waveform is called THD (total harmonic distortion) and can be further classified into total harmonic voltage distortion and total harmonic current distortion.

A flyback converter is as shown in Fig 1. When the switch is on, the input voltage is forced across the transformer primary which causes an increasing flow of current through it causing a voltage with the same polarity to appear at the transformer secondary (the magnitude of the secondary voltage is set by the transformer secondary to primary turns ratio).

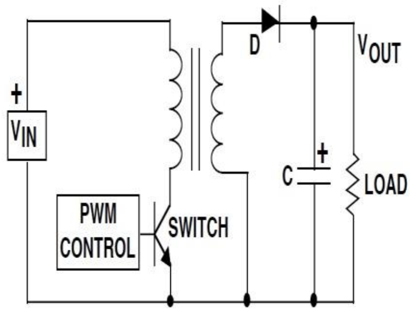

Fig 1. Circuit diagram of Flyback converter

A Thyristor is used instead of Diode at the secondary winding for the continuous conduction mode. A gating signal is applied to the thyristor to turn ON the thyristor in this work. Power factor is a very important factor while designing any power systems in the present power electronic conversion system, based on this power factor the system will be evaluated.

At the input of the fly-back converter, current harmonics are dominant, in order to remove these harmonics LC filter is used. Many of the harmonic filters designs are available today and it consists of parallel connected capacitor and inductor circuits. The presence of harmonics results in poor power factor, failure of operation, and poor efficiency, shortens equipment life. And even it leads to overheating of lines, transformers and generators to excessive iron losses.[6-10]

II. SINGLE PHASE INVERTER WITH FLYBACK THYRISTOR CONVERTER

The block diagram of thyristor flyback converter is as shown in Fig 2. To improve the power factor and remove the harmonics LC filter is used in between the converter and inverter.

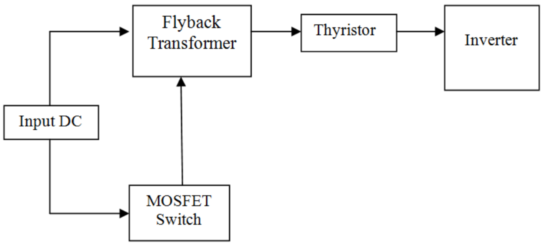

Fig 2. Block diagram of flyback thyristor converter

A. Normal Thyristor Flyback converter

The circuit diagram of thyristor flyback converter is shown in Fig.3 constructed with simulink. It has a DC source as input, a transformer with MOSFET as a switch at the primary side and a thyristor with single phase inverter at the secondary side.

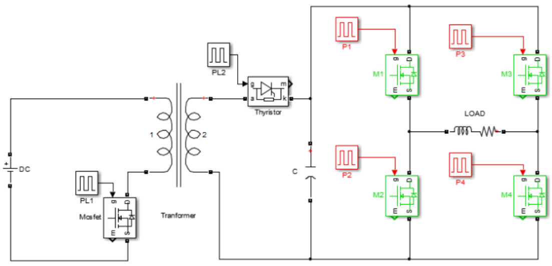

Fig 3. Circuit diagram of normal thyristor flyback converter

B. Thyristor Flyback converter with Filter

A LC filter is used to remove the harmonics. LC filter is designed with reference to the resonant frequency f_0.

$$f_0 = \frac{1}{2\pi\sqrt{LC}} \qquad (1)$$

By using eqation.1 filter is designed for different L values keeping the capacitor value constant. And circuit diagram of Thyristor Flyback converter with LC Filter constructed with simulink is as shown in Fig 4.

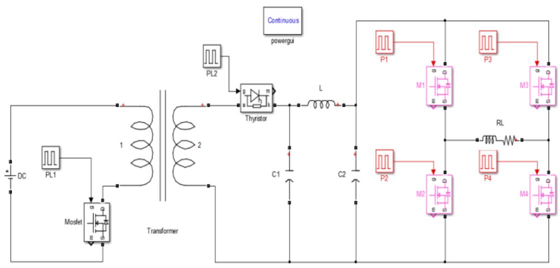

Fig 4. Circuit diagram of Thyristor flyback converter with filter

The values of L are calculated according to the various resonant frequencies as shown in table 1.

TABLE I. INDUCTOR AND CAPACITOR VALUES

Resonant Frequency f_0 in k Hz	L (m Henry)	C (µF)
0.5	1	22
1	0.46	22
1.5	0.5	22
2	0.28	22

III. SIMULATION RESULTS

In simulink the work has been carried out in 2 stages. In 1st stage harmonics and power factor is measured for normal flyback thyristor converter. In stage 2 harmonics and power factor is measured for flyback converter using thyristor with filter for various values of L. Input DC voltage is set to 100V for both stages.

A. Stage 1

Simulation has been done for normal flyback thyristor and single phase output voltage is obtained as shown in fig 5. FFT analysis has been done for this output voltage, FFT analysis is as shown in Fig 6.

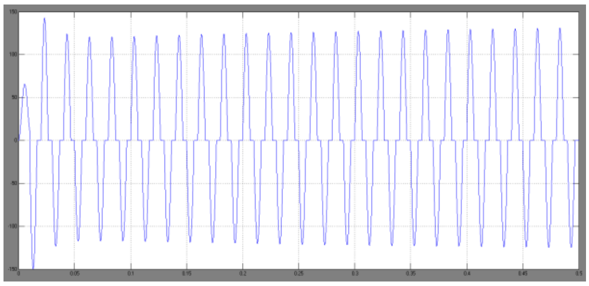

Fig 5. Output voltage of single phase flyback thyristor converter

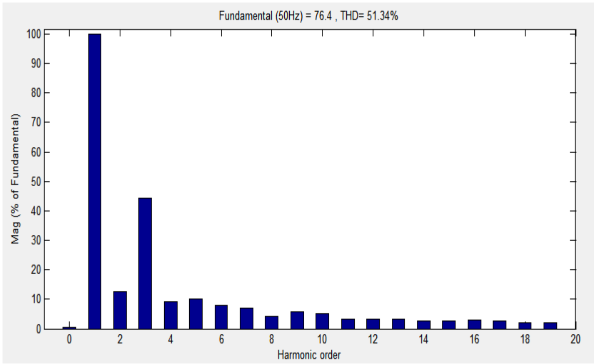

Fig 6. FFT analysis of output voltage

B. Stage 2

Simulation has been done with LC filter for different values of resonant frequency f_0 and output voltage waveform of single phase flyback thyristor with LC filter is as shown in Fig 7. FFT analysis has been done for different values of L keeping the capacitor as constant. FFT analysis of Single phase flyback thyristor with filter for 500 Hz, 1.5k Hz, 2 k Hz are as shown in Fig 8, Fig.9 and Fig.10 respectively.

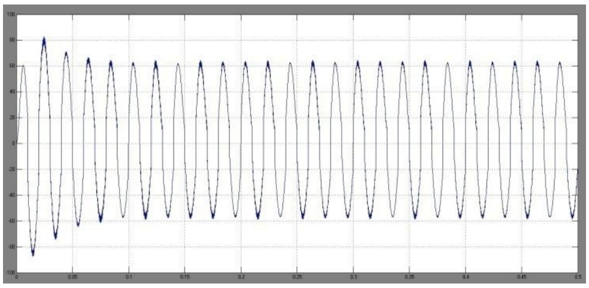

Fig 7. Output voltage of single phase flyback thyristor converter with filter

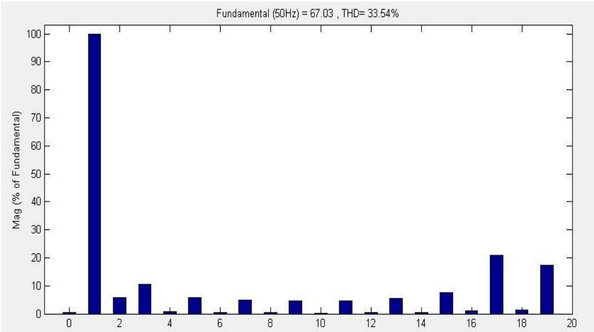

Fig 8. FFT analysis with filter for f_0 = 500 Hz

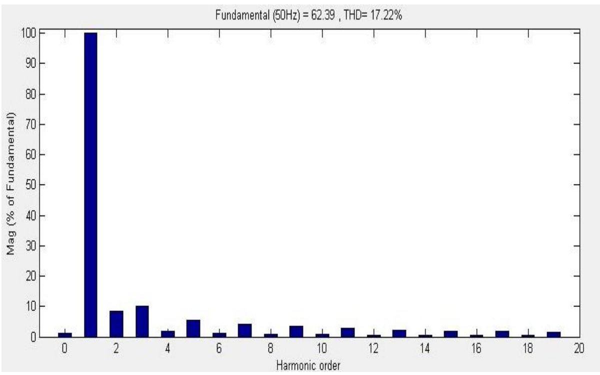

Fig 9. FFT analysis with filter for f_0 = 1.5 k Hz

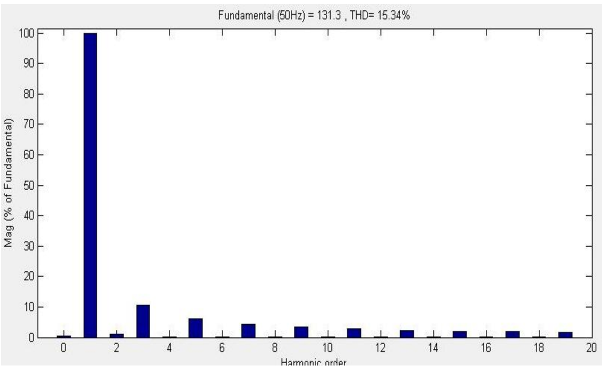

Fig 10. FFT analysis with filter for f_0 = 2 k Hz

Table II and III shows the comparison of Power factor and THD between the normal Flyback Thyristor converter and Flyback Thyristor with Filter at different f_0.

TABLE II. COMPARISON OF POWER FACTOR

Modes	Power Factor
Normal Flyback Thyristor (Without Filter)	0.963
Flyback Thyristor with Filter	0.996

TABLE III. THD COMPARISON

Modes	THD
Normal Flyback Thyristor (Without Filter)	51.34
Flyback Thyristor with Filter (f_0 = 500 Hz)	33.54
Flyback Thyristor with Filter (f_0 = 1.5 k Hz)	17.22
Flyback Thyristor with Filter (f_0 = 2 k Hz)	15.34

IV. CONCLUSION

The construction of fly-back converter using thyristor has been designed with Simulink Matlab, for Single phase Inverter drive. The output of the Total Harmonic Distortion and Power factor are studied for various frequencies with normal fly-back converter and with LC filter between fly- back converter and Inverter. The Total Harmonic Distortion and power factor of normal fly back converter is compared with the fly-back converter with LC filter. It is concluded with evidence of the results that the THD and power factor is found to be less with LC filter.

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