# Half bridge converter with LCL filter for battery charging application using DC-DC converter topology

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Abstract— For the developing energy conveyance challenges, With the fast advancement of semiconductor and power electronic methods, the DC distribution system is prepared as an option plan to the existing AC distribution system because of its powerful quality and unwavering quality execution. Half Bridge Converter (HBC) or Full Bridge Converter were the regularly utilized topologies. Among them, Half Bridge converter has critical part in power gadgets and drives application. The converter can be proposed in distinctive routes as per the range of utilization. An adjustment is made with the current HBC by the expansion of LCL channel at input side to reduce the inrush current, voltage stress on switches and di/dt losses. The principle point of preference of utilizing the proposed converter is to decrease the input current swell without including a vast input channel. Consequently the HBC with LCL channel is the proposed topology which can shape the input current waveform to a non-throbbing design.

# *Keywords*— Full-bridge, voltage spikes, LCL Filter, Low voltage Rectification, current swell

## I. INTRODUCTION

The late headway of power gadget principally by the development of MOSFET has made conceivable to enhance execution of power electronic gadgets. MOSFET are prominently utilized because of its higher frequency, high impedance, low voltage stress and for the most part expend less DC power. DC-DC converters are broadly utilized as a part of modern applications, for example, dc engine drives, office apparatuses and correspondence supplies [1].DC-DC converters are constantly vital to change over the dc transport voltage to various voltage levels for the load gadgets. DC-DC converters have high productivity, high power thickness, high voltage pick up and diminished swell voltage. The normal sorts of DC-DC converters are isolated into two sorts on how they exchange the vitality. vitality can go from the input to the magnetic through load or the vitality can be put away in the magnetic to be discharged later to the load [2,3]. In this project among the DC-DC converters Half Bridge Converter (HBC) is generally used to have low voltage stress, low EMI and high productivity execution. LCL Filter is added with the HBC to decrease the current ripple. The exploratory circuit researched in this project is DC-DC HBC converter, which permits the change of vitality from higher level to lower level [4,5]. HBC with LCL channel is utilized to diminish the inrush current, diminish the switching losses and to accomplish high recurrence operation. The span of LCL channel is diminished which is a fundamental point of preference. This is broadly utilized as a part of numerous other distinctive mechanical applications, for example, battery charging applications,

office applications and in telecom gadgets. The investigation was completed on the Matlab – Simulink and the outcome affirm the reduction of input current ripple and diminished voltage spikes.

The LCL filter is shown in below Fig.1 which is used for the most part utilized with a transformer as a part of half bridge converter or full bridge converter. which has been promising way to deal with decrease harmonic current, also, to decrease the inrush current. The DC qualities of LCL filter can be determined by two resonant frequencies. One is low resonant frequency and another is high resonant frequency. Lr and Cr decide the higher resonant frequency and Lm and Lr decide the lower resonance frequency.



### Fig.1: LCL filter

. The frequency is wide range and less stress on rectifiers expressed as

 $f0 = 1/2\pi\sqrt{Lr} Cr$ ,  $Q = \sqrt{Lr} Cr Ln = Lm / Lr$ 

Where, fo – frequency Q – Quality factor Ln – ratio between magnetizing and resonant Inductors Lm and Lr. The features of LCL filteres are progressed efficiency with less switching losses, restricted frequency variation range over. Both these working conditions diminish the input current ripple

#### 2. CIRCUIT OF NEW PROPOSED TOPOLOGY

Block diagram of half bridge converter LCL Filter system is shown in Fig.2 which consists of half bridge converter with LCL filter which is placed at the input side because to reduce the input current ripple, voltage stress, lossless snubbing and voltage clamping features here input is fed by fixed DC.



Fig 2: New Topology Block diagram

Proposed half bridge converter with LCL filter mainly consists of a capacitor embedded between two primary windings of the transformer. It is utilized to decrease the input current ripple, and to accomplish low voltage stress, lossless snubbing and voltage clamping features. The proposed converter decreases the Electromagnetic Interference issue also. A number of bridge sort converters have been proposed. The span of the input filter can be diminished without including a huge input filter. The expense additionally decreases. During turn off interval a non - zero input current is kept up and during turn on interval the input current is shared. The voltage spike over the switch is wiped out by absorbing the leakage inductance.

# 3. Operation of Proposed Half Bridge Converter with LCL Filter

Fig 3 shows the Proposed half bridge converter with LCL filter.



Fig 3: The Proposed half bridge converter with LCL filter.

Half Bridge Converter is an attractive topology further, utilized for middle power applications because of its simplicity. The half bridge converter is another type of a isolated forward converter. At the point when the voltage on the power transistor in the single finished forward converter since too high, the half bridge converter is utilized to decrease the voltage stress. One of the primary features of half bridge converter is it decreases the off stage voltage stress. In this manner the expense and voltage stress is lessened. The half bridge converter goes about as a forward converter yet it utilizes a bridge circuit which comprises of two transistors to drive the transformer. The half bridge converter can be utilized as two back-back converter. The output of HBC is twofold to that of forward converter supplying the same input voltage. The half bridge converter begins starting from the step down converter. The equal valued capacitors C1 and C2 are embedded over the DC voltage in series shaping the half VDC to primary winding of the transformer. The DC voltage VDC/2 or - VDC/2 is connected.

The MOSFET switches S1 and S2 conduct on the same duty cycle. The two switches associate the transformer over the capacitors on the other hand. Full Bridge Converter requires additional capacitor to dispense the DC bias in transformer. However, in the proposed Half Bridge Converter additional capacitor is not required in light of the fact that the two transistors itself automatically correct the distinction of the switching by changing their voltage. Half Bridge Converter starts from the buck converter. The MOSFET voltage stress is half of the input voltage in HBC in light of the fact that the two capacitors share the input voltage evenly. The operation of half bridge converter can be explained in two modes as per the switching ON of two switches T1 and T2.

#### MODE 1

Model begins when switch T1 is ON. This happens during first DTs period. The input source voltage Vin is associated with one end of the primary winding through switch T1. Another side is at Vin/2. The voltage over the primary is Vin/2 with the data end being positive with respect to non spot end. The diode D1 is ON and D2 is OFF. The vitality is supplied to energize the inductor through the diode D1.

#### MODE 2

This mode begins when the switch T2 is ON. This happens amid the second DTs time frame. T1 and T2 will be ON amid alternate DTs periods with D and Ts being characterized with respect to the inductor current swell. Amid this time, T2 is ON and the voltage over the primary winding is Vin/2., however the dot end is negative concerning the non dot end. This will facilitate the center flux to swing in the negative direction. In auxiliary, D2 is ON and D1 is reverse biased. The inductor energy is flow through diode D2. At the point when both T1 and T2 are OFF, the inductor current freewheels through both D1 and D2. The current streaming in the center tapped auxiliary is in directions that will drop the flux in the center because of each other. This will prompts the voltage over the entire transformer being zero. The half bridge converter with LCL filter at input side shown above which reduce the input current ripple, voltage stress, and also reduce the switching losses.

#### 4. SIMULTION RESULT

The result is obtained with the MATLAB software using simulink. The proposed Half Bridge converter with LCL filter topology has been simulated in the MATLAB Simulink environment using the components as selected in the parameter table shown below

Sl.No	Parameters	Values
1	Input voltage (vin)	360v
2	Output voltage (vout)	12v
3	Duty cycle (D)	0.42
4	Switching frequency	100KH <sub>Z</sub>
5	Leakage inductance ( $_{L1,L2}$ )	1.03μH 1.18μH
6	Capacitor (C1)	4.7μF
7	Load resistance	10022

Open loop analysis is done for the half bridge converter with LCL filter where the input of 260v is stepped down to 12v by

using the above components listed in the table

The open loop simulation is done at the frequency level of 100kHz and simulation results are shown in Fig.4 that shows

the input voltage of 250v is successfully stepped down to 12v.



The below Fig.5 shows the waveform of both output and input waveforms



Fig.5: Output and input voltage waveform

A Closed-circle Control System, otherwise called a feedback control system is a control system which utilizes the idea of an open loop system as its forward way but has one or more

feedback loop (subsequently its name) or ways between its output and its input. The referenceto "feedback" essentially implies that some bit of the output is returned "back" to the input to shape part of the system excitation. The Closed loop Simulink Model of DC-DC converter half bridge converter with LCL filter is shown in Fig. 6



Fig.6 Closed loop simulink model

**Design of circuit parameters :** 

$$Q_{max} = 8.1649 \times 10^{-5}$$

$$R_{ac} = \frac{8 \times n^{2} \times R load}{\pi^{2}}$$

$$R_{ac} = \frac{8 \times 81 \times 100}{\pi^{2}} = 7878.73$$

$$L_{1} = \frac{Qmax \times Rac}{2 \times \pi \times Fr1}$$

$$L_{1} = \frac{8.1649 \times 10^{-5}}{2 \times \pi \times 100 \times 10^{-3}}$$

 $L_{1=1.023}\mu_{h}$ 

$$C_{l} = \frac{1}{2 \times \pi \times fr1 \times Qmax \times Rac}$$

$$C_1 = \frac{1}{2 \times \pi \times 100000 \times 8.1649 \times 10^{-5}}$$

 $C_1 = 4.123 \mu F$ 

$$F_{r1} = \frac{1}{2 \times \pi \times Cr \times Qmax \times Rac}$$

Fr1=60 kHz

Recalculate L1 with new Fr1 value

# $L1=1.17 \mu F$

The Simulink model for the proposed converter closed loop model and waveform shown in Fig.7, where the input voltage of 250v successfully stepped down to 12v by using MATLAB Simulation software.



Fig.7 Output voltage waveform

# **5. CONCLUSION**

The proposed half bridge converter with LCL filter at input side reducing the voltage stress and di/dt losses, input current ripple. This topology successfully stepped down operation for the input 360v to 12v for the switching frequency of 100 KHz which is simulated using MATLAB and the output waveforms are analyzed. In compare with LLC filter, LCL performs well and it is not sensitive to the parameters of L&C. It does not require large input filter, due to this proposed converter is

suitable for DC-DC converters, office application, telecom, communication device and for battery charging application.

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