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Harmonics Reduction of a Single Phase Half Bridge Inverter

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Abstract - This paper displays a way to deal with minimize the sounds contained in the output of a solitary stage half scaffold inverter. With a perspective to decreasing Harmonic a LC low pass filter is utilized which hinders the music and irrefutably passes verging on sinusoidal yield at the yield terminal. A representation of Fourier Transform has been given in this paper with a specific end goal to see both the basic and music part decisively. It has been found from recreation that the Total Harmonic Distortion (THD) previously, then after the fact the application is 44.999% and 0.0183% separately. That is the reason, this LC low pass channel is very compelling to diminish THD of a 1-stage half extension inverter.

Keywords : single phase half bridge inverter, IGBT, harmonics analysis, FFT, THD, LC low pass filter, MATLAB simulation.

I. INTRODUCTION

Dc-to-Ac converters are known as inverters. The capacity of an inverter is to change a dc voltage to a symmetric air conditioning yield voltage of wanted extent and recurrence [1]. Some normal applications are variable rate air conditioning drives, impelling warming, standby force supplies, un-interruptible, power supplies(UPS), footing, HVDC et cetera [2].

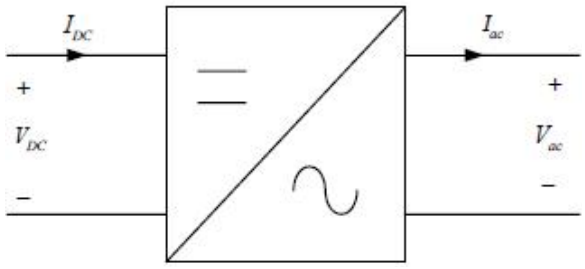

Figure 1 : General Block Diagram of Inverter

Inverters can be broadly classified into two types such as single phase inverters and three phase inverters. The output voltage could be settled or variable at an altered or variable recurrence. A variable yield can be gotten by fluctuating the data dc voltage and keeping up the addition of the inverter consistent. The yield waveforms of a perfect inverter ought to be sinusoidal. In any case, the waveforms of down to earth inverters are non sinusoidal and contain certain sounds which can be seen effortlessly in recurrence space. Because of the accessibility of rapid force semiconductor gadgets, the symphonious substance of yield voltage can be minimized or diminished essentially by exchanging method. BJTs, MOSFETs or IGBTs can be utilized as perfect changes to clarify the force transformation strategies. Be that as it may, IGBT is more prevalent as it consolidates the benefits of BJTs and MOSFETs. An IGBT has high info impedance, as MOSFETs, and low on state conduction misfortunes like BJTs [3-4]

Total Harmonic distortion (THD) is a measure of closeness in shape between a waveform and its fundamental component. For improvement purpose, a LC Low pass filter is appended at the output terminal that provides low harmonic impedance to ground [5].

II.SINGLE PHASE HALF BRIDGE INVERTER

A half bridge inverter consists of a three wire dc source in which $V_s/2$ voltage is obtained across the load as seen in Figure 2. When Q_1 is turned on and Q_2 is turned off, the instantaneous voltage across the load is $V_s/2$ as observed in Figure 2. On the other contrary, if Q_2 is turned on and Q_1 is turned off then according to figure 2. - $V_s/2$ voltage appears across the load. The logic circuit is designed in a way that Q_1 and Q_2 are not turned on at the same. Otherwise, dc source may be shorted out. So, there must a dead time between the switches [6].

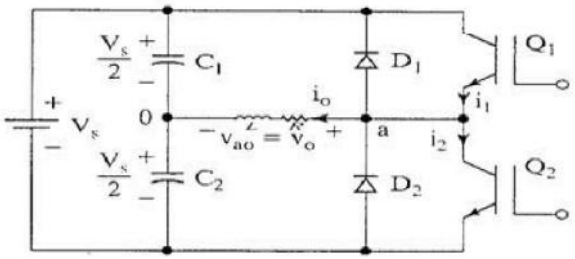

Figure 2 : Circuit Diagram of Single Phase Half Bridge Inverter

Instantaneous inverter output voltage,

$$vo = \sum_{n=1,3...}^{\infty} 2\frac{Vs}{n\pi}\sin nwt$$

Instantaneous inverter output current,

$$io = \sum_{n=1,3...}^{\infty} 2\frac{Vs}{n\pi\sqrt{R^2+(nwL)^2}}\sin(nwt-\theta n)$$

III. IGBT

The Insulated Gate Bipolar Transistor (IGBT) is a minority-bearer gadget with high information impedance and substantial bipolar current-conveying ability. Numerous architects view IGBT as a gadget with MOS information attributes and bipolar yield trademark that is a voltage-controlled bipolar gadget. To make utilization of the benefits of both Power MOSFET and BJT, the IGBT has been presented. It's an utilitarian reconciliation of Power MOSFET and BJT gadgets in solid structure. It consolidates the best credits of both to accomplish ideal gadget attributes [6].The IGBT[7] is suitable for some applications in force hardware, particularly in Pulse Width Modulated (PWM) servo and three-stage drives requiring high element range control and low commotion. It additionally can be utilized as a part of Uninterruptible Power Supplies (UPS), Switched-Mode Power Supplies (SMPS), and other force circuits requiring high switch reiteration rates. IGBT enhances dynamic execution and effectiveness and diminished the level of capable of being heard clamor. It is just as suitable in thunderous mode converter circuits. Streamlined IGBT is accessible for both low conduction misfortune and low exchanging misfortune. Without a clue of uncertainty an IGBT is the most well-known gadget decided for new power hardware applications. It has most astounding abilities up to 1700KVA, 2000V and 800A [8].

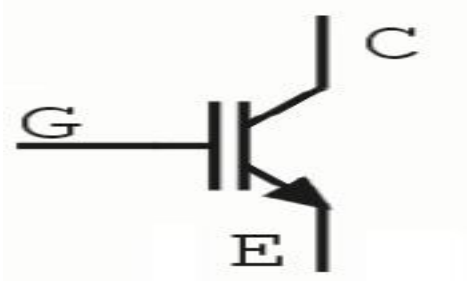

Figure 3 : Circuit Symbol of IGBT

A circuit symbol for the IGBT is shown in Figure 3.

IV. HARMONICS ANALYSIS

A harmonic is a signal or wave whose recurrence is a vital (entire number) numerous of the recurrence of some reference flag or wave. The term can likewise allude to the proportion of the recurrence of such a sign or wave to the recurrence of the reference flag or wave. Let f speak to the principle, or key, recurrence of a rotating current sign, electromagnetic field, or sound wave. This recurrence, normally communicated in hertz, is the recurrence at which the majority of the vitality is contained, or at which the sign is characterized to happen. In the event that the sign is shown on an oscilloscope, the waveform will seem to rehash at a rate comparing to f Hz.

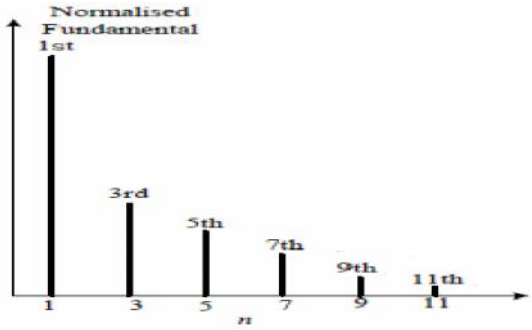

Figure 4 : Harmonic Spectra of an Inverter

As is watched, Harmonic abatements as n increments. It diminishes with a component of (1/n). Indeed, even sounds are absent–Nearest music is the third. In the event that principal is 50Hz, then closest consonant is 150Hz. Because of the little partition between the key a music, yield low-pass channel outline can be entirely troublesome [8]. The impacts of sounds are unsavory because of the way that these reason unbalance and over the top impartial streams. Sounds offer ascent to impedance in adjacent correspondence systems and unsettling influence to different purchasers. In electric engine drives, they cause torque throbs and cogging [9].

V. FFT ANALYSIS

It is a linear algorithm that can take a time domain signal into the frequency domain and back. Fourier analysis allows a more intuitive look at an unknown signal in frequency domain [10].As is presented in Figure 4. the fundamental component & the harmonic components can be understood without cumbersome. VI. THD

Total Harmonic Distortion is a measure of distortion of a waveform. It is given by the expression

$$THD = \sqrt{\frac{Im^2 - Im_1^2}{Im^2_1}}$$

Therefore, it is needless to say that THD can be defined as the ratio of the RMS value of all odd number of non fundamental frequency terms to the RMS value of the fundamental [10].

VII. LC LOW PASS FILTER

The implementation of an LC filter at the inverter ac terminals could trigger a parallel resonance which tends to amplify the harmonic voltages and currents in ac network leading, in some cases, to potential harmonic instabilities owing to the fact that the filter capacitance has a profound impact on the harmonic performance [8,10]. An LC low pass filter is used to bring the harmonics into a lower state [9].

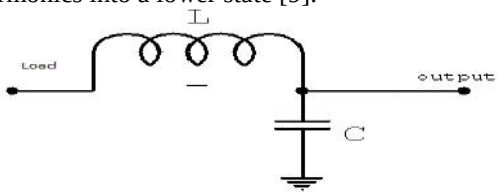

Figure 5 : LC low pass filter

VIII. SIMULATION AND RESULT

It is assumed that input voltage is 220V. Other necessary parameters are considered deliberately with assuming up to 15th harmonics prevalent at the output so as to [Equation 1 and 2] can be plotted using [10]. According to the illustration, Figure 6. And Figure 7. deal with the inverter output voltage in time domain and frequency domain respectively whereas inverter output current both in time domain and frequency domain have been demonstrated in Figure 8 and Figure 9 respectively.

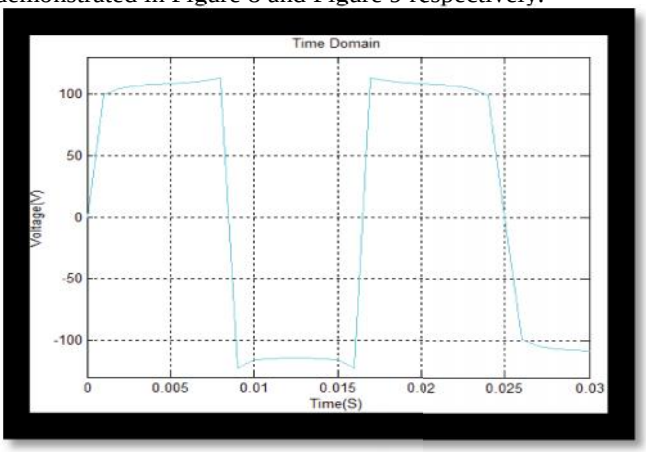

Figure 6 : Time domain Response of Inverter Output Voltage with Harmonics up to 15th

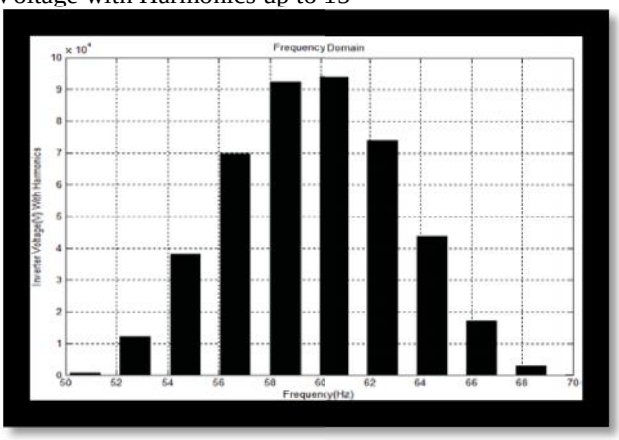

Figure 7 : Frequency domain Response of Inverter Output Voltage with Harmonics up to 15th

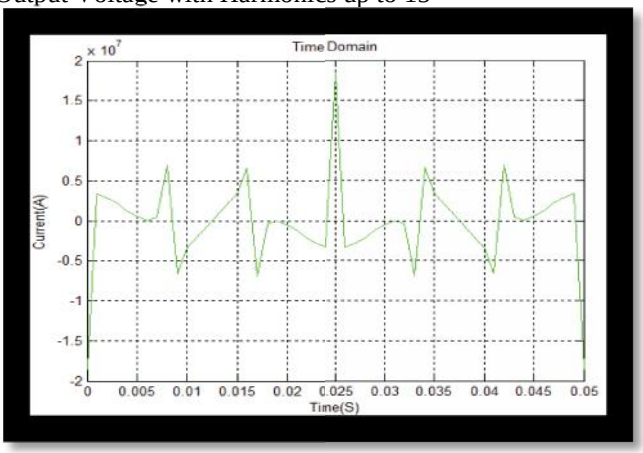

Figure 8 : Time domain Response of Inverter Output Current with Harmonics up to 15th

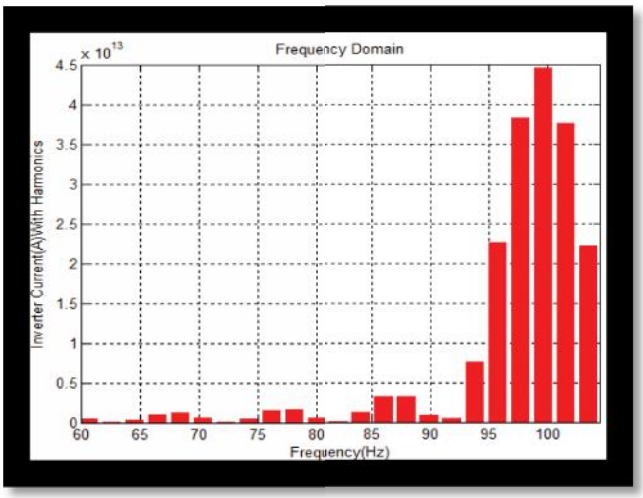

Figure 9 : Frequency domain Response of Inverter Output Current with Harmonics up to 15th

There is no denial that too much harmonics exist at the output even though fundamental frequencyis 60Hz. In this case applying [Equation 3] obtained THD is 44.999% which is unquestionably excessive and is needed to be mitigated for better performance. Thence, An LC low pass filter is connected with the load and the output is taken across the capacitance having 10000F value so that it has an effect on the present harmonics. Finally, the output is plotted using again and nearly a sinusoidal response is observed which has been depicted in Figure 10. Furthermore, from frequency domain response described in Figure 11, it is found that the fundamental component has the highest amplitude.

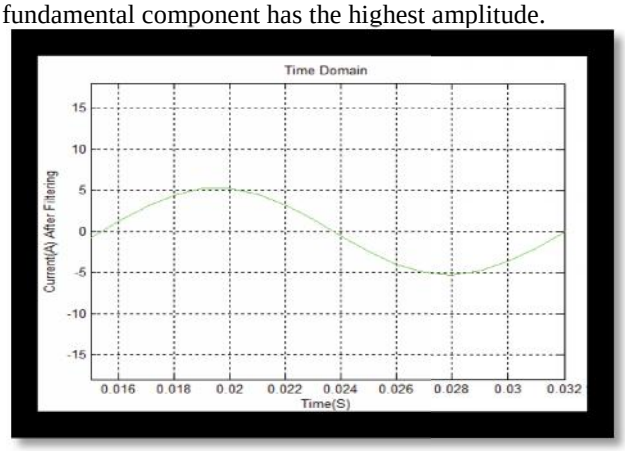

Figure 10 : Time domain Inverter Output Response after appending an LC low pass Filter

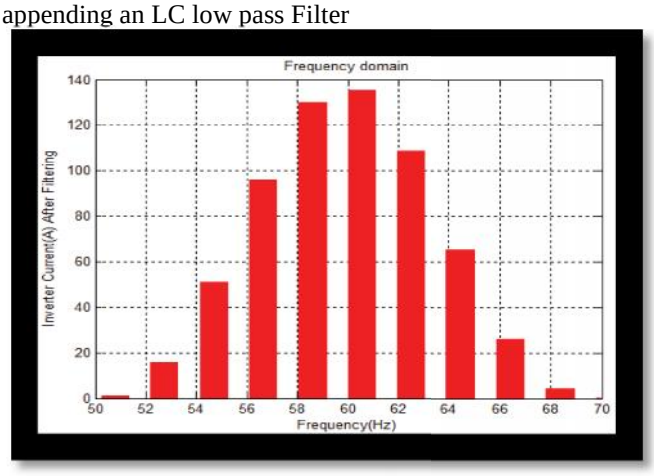

Figure 11 : Frequency domain Inverter Output Responses after appending an LC low pass Filter Here, calculated THD is 0.0183%.

IX.RESULT AND DISCUSSION

At normal condition, when up to 15th harmonics are considered then there exists 44.999% THD. But as soon as an LC low pass filter is implemented it has been dropped to 0.0183%. Therefore, a vast improvement has been noticed. A single phase half bridge inverter finds a broad usage in variable pace air conditioning drives, instigation warming, standby force supplies, uninterruptible force supplies(UPS), footing, HVDC, framework association of renewable vitality sources thus on because of straightforward plan and savvy viewpoints. On the other hand, not at all like single stage full scaffold inverter the greatest air conditioning voltage is restricted a large portion of the estimation of full dc voltage source. Again it might require an inside drew from source. Presently, in the event that it is expected to get higher air conditioning voltage then a stage up transformer can be utilized. In coming days, utilizing this idea, the yield reactions of single stage full extension inverter can be seen and in addition the music happened at the yield can be minimized by applying LC low pass channel. A usage of second request LC low pass channel would be intriguing for this situation.

REFERENCE

1. H. Salehfar, “DSP-Based Implementation of Vector Control of Induction Motor Drives,” Taylor & Francis Group, LLC, 2005.
2. Mehmet Yumurtaci, SeydiVakkasUstun, Secil Varbak Nese and HasanCimen, “Comparison of Output Current Harmonics of Voltage Source Inverter used Different PWM Control Techniques”, WSEAS Transactions on Power Systems, Issue 11, Vol. 3, Nov. 2013, pp. 695-704.
[3]. Anand. D & Jeevananthan .S "Modeling and Analysis of Conducted EMI Emissions of a Single-Phase PWM Inverters" Asian Power Electronics Journal, Vol. 4, No.3 December 2010.
[4]. Crowley. Ian. F & Leung. H. F "PWM Techniques: A Pure Sine Wave Inverter" Worcester Polytechnic Institute Major Qualifying Project, 2010.
[5]. Kim. J, Choi. J & Hong. H, "Output LC Filter Design of Voltage Source Inverter Considering the Performance of Controller" IEEE Conference Publications, 2000.
[6]. Lin.W.Song & Huang.I.Bau “Harmonic Reduction in Inverters by Use of Sinusoidal Pulse Width Modulation” IEEE Transactions on Industrial Electronics - IEEE TRANS IND ELECTRON , vol. IECI-27, no. 3, pp. 201-207, 1980
[7]. Gole.A.M “Harmonic Elimination in SPWM Inverter"1994, Halifax, Canada.
[8]. Rashid. M.H, “Power Electronics circuits devices and applications”, PHI 3rd edition,2004 edition, New Delhi.
[9]. Bimbhra .P.S "Power Electronics" Khanna Publishers, New Delhi, 2003. 4th Edition
[10]. Mohan.N, Undeland.T &Robbins.W, “Power Electronics Converters applications and design” 2nd edition, John Willey & sons, Singapore.