

Modeling of A 18 Pulse Converter For Improving Quality In Line Current Using 3-Phase Inverter

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Abstract—

In high electric power conversion applications, single-phase or three-phase full-bridge rectifiers have been the most popular converter as the first stage connected to the utility. Unfortunately, these rectifiers drew non-sinusoidal currents from the source. To regulate these problems and maintain power quality, many strategies and topologies have been proposed to deal with these problems so as to meet the requirement of the standards. In this paper, a new topology will be used for receiving quality power of a conventional 18-pulse ac/dc converter formed by using three 6-diode bridges and to reduce the total harmonic distortion, we used hysteresis controller to give pulses. To maintain quality in line current and reduce THD we using 18-pulse converter with 3-phase inverter.

Key Words—Hysteresis controller, Inter phase Reactor (IPR), 18-pulse converter, THD.

I. INTRODUCTION

In high electric power renovation applications, 1-phase or 3-phase Full-bridge rectifiers have been the most popular converter as the primary stage allied to the utility. Regrettably, these rectifiers drew non-sinusoidal currents from the utility and led to harmonic pollution on the grid. To reduce these problems and maintain power quality, many strategies and topologies have been anticipated to deal with these problems so as to meet the obligation of the standards. Along with them, multi pulse schemes played an important role due to their consistency, density, and effectiveness of cost. One more advantage of multi pulse methods was that they could only be implemented by uncontrollable semiconductor devices i.e., Diodes. The basic design of multi pulse ac/dc converters is to connect multiple rectifier bridges simultaneously, either in parallel or in series at the dc side, so that some lower order characteristic harmonics produced by one rectifier can be canceled by other rectifiers. Multi pulse transformers with different configurations were introduced. In addition, in parallel multi pulse methods, an inter phase Reactor was needed at the dc side to average the output voltage of each

rectifier. The enhancement in line current conditions by these multi taped IPR methods was inadequate. An ac-side current injection mechanism was proposed to improve the line conditions of a 3 phase diode bridge. The main advantage was only passive elements were used to attain the goal. The model of an active Inter Phase Reactor was first anticipated in 12-pulse and 24-pulse diode converters, which enhanced the line quality by injecting compensation current into the extra winding of the Inter Phase Reactor with a low kilovolt-ampere rating inverter. However, the control strategy is enhanced only one phase line current of the three-phase source though, the other two phase line currents were still highly imprecise. The ac main currents were improved by directly injecting. The compensation currents into 3 positive terminals of the three 6-diode modules. The idiom “directly injecting” means that the proposed method provided the compensation currents without modifying any parts of the 18-pulse converter, even the Inter Phase Reactor.

II. EXISTING SYSTEM

This 18-Pulse Converter System having multi pulse transformers, 3sets of 6-diode bridges and a 3winding Inter Phase Reactor.

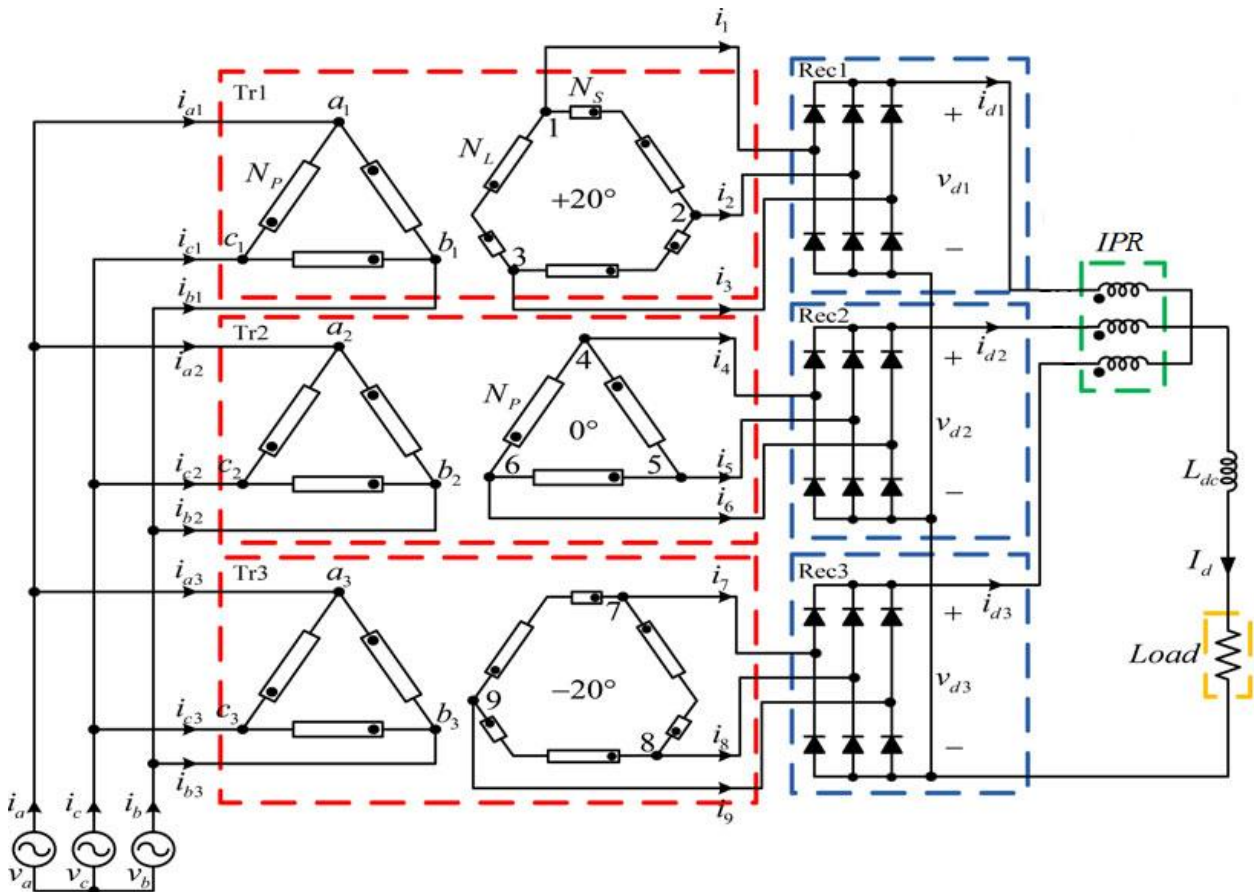


Fig 1. 18 pulse converter system

The set of multi pulse transformer including one delta-delta connection and two delta polygon connection provides three 3-phase sources for the 3-diode bridges with $+20^\circ$, 0° and -20° phase shift respectively. The secondary sides of the 3 phase shift transformers denoted as Tr1, Tr2 and Tr3 connected to the 3 diode bridges represented as Rec1, Rec2 and Rec3 respectively. The currents from the Transformer $i_1, i_2, i_3, i_4, i_5, i_6, i_7, i_8, i_9$ are connected as the inputs of the rectifier 1, 2 and 3. All of the diode bridges negative terminals are connected together, though the 3 positive terminals connected to the three non-common terminals of inter phase reactor and connected to the load I_d . The voltages taken from the rectifiers output as for rec1 its v_{d1} , rec2 its v_{d2} and rec3 its v_{d3} and the currents are i_{d1}, i_{d2} , and i_{d3} respectively.

18-Pulse systems have become economically feasible due to the recent advantages in autotransformer techniques that help to reduce the overall cost and achieve low total current harmonic distortion and gives quality line current. When employing autotransformers, care should be taken to force the different rectifier units to share the current properly. . The 18 pulse configuration lends itself better in achieving this goal compared to 12 pulse scheme.

For 18 pulse configuration there is need for 3sets of 3phase ac supply that are phase shifted with respect to each other by 20 electrical degrees. Traditionally, this is achieved using a 4winding polygon transformer that has one set of primary windings and 3sets of secondary windings. One set of secondary winding is in phase with the primary winding, while the other two sets are phase shifted by secondary $+20$ and -20 electrical degrees with primary. This arrangement yields three phase shifted supplies that allow 18pulse operation.

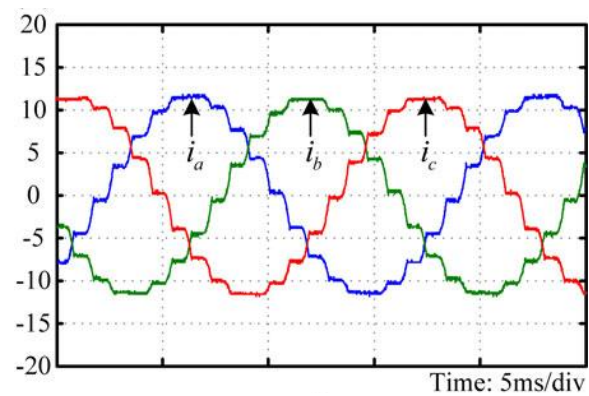


Fig 2. Line current of 18-pulse converter

III. DRAWBACKS OF EXISTING METHOD

- Ripples are presented in Line current
- Power quality is Low
- Harmonics are Present
- Efficiency of the line current is Reduced
- Total Harmonic Distortion is high

IV. PROPOSED TOPOLOGY

Modeling of a 18-pulse converter for improving quality in line current using 3-phase inverter. To improve the line current in ac we injecting i_{x1} , i_{x2} , i_{x3} currents to the 3 non-common terminals of the inter phase reactor from the 3 output terminals of the 3phase current controlled inverter. The current controlled inverter injects the compensation currents into the terminals of the Inter Phase Reactor according to the proposed topology that leads to nearly sinusoidal line currents of Ac system. Although that the direct connection the proposed topology can adapt easily to an 18-pulse converter system without any modification. When the inverter is disconnected from the proposed topology, the 18-pulse converter still can be recommence its original performance.

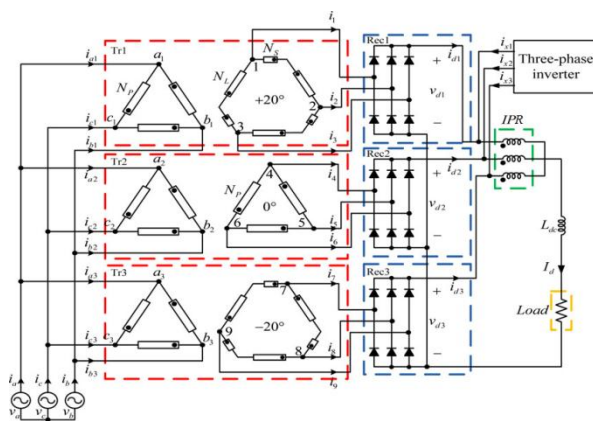


Fig3. 18pulse converter with 3phase inverter

3-PHASE INVERTER AND THE CONTROL SCHEME

The 3 phase inverter was built using IGBTs. We are using 6 IGBTs, each connected parallel with diodes represented $S_1, S_2, S_3, S_4, S_5, S_6$, respectively, V_{dc} is the source voltage to the inverter and the triggering pulses for the IGBTs are given by using PWM technique generating by the DSP. In Dsp the compensating currents command generator generate the currents $I_{x1}^*, I_{x2}^*, I_{x3}^*$ respectively and it sends those currents into comparators. Those comparators are taken the generating currents and also taken I_{x1}, I_{x2}, I_{x3} currents from the outside of the comparator by using A/D module, later on comparator compare the two currents and send it to the PWM. The PWM gives the triggering signals for the IGBTs $S_1 \sim S_6$.

The triggering signals gives to the IGBTs, the switches are on and the inverter action takes place. By using the Digital signal processor controller we will give triggering signals to the switching devices (IGBTs). The output current of the 3-phase inverter gives the inputs of the Inter Phase Reactor in 18-pulse converter system.

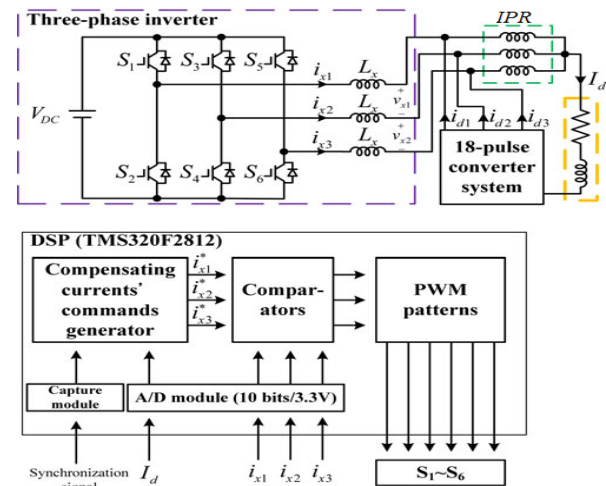


Fig 4. 3-phase inverter and control scheme

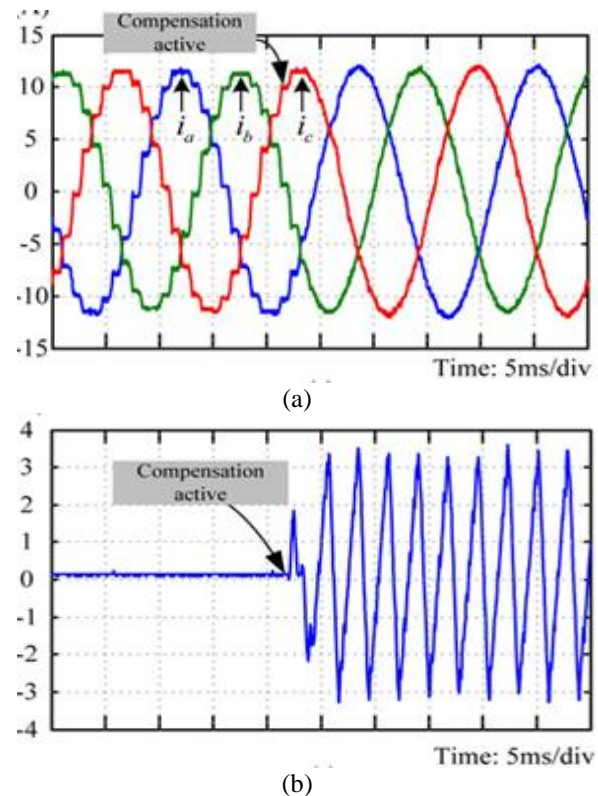


Fig5. (a) Overall ac line currents, i_a , i_b , and i_c .
 (b) Injection current i_{x1} .

V. ADVANTAGES

- Sinusoidal input currents and output-voltage regulation were achieved
- Line current is improved.
- Reduces the unbalanced source voltage effects.
- It also take the advantages of reliability, simplicity, and cost effectiveness
- Total Harmonic Distortion is reduced.

PARAMETERS

Symbol	Description	parameters
V_{LL}	rms value of the ac source	220V
$N_P:N_L:N_P:N_D$	turn ratios of transformer windings	220:86.9:163.3:220
R_{load}	dc load resistor	28 Ω
L_{load}	dc filter inductor	9.5mH
L_x	Inverter boost inductor	3.5mH
V_{DC}	dc source of inverter	120 kv
f_c	switching frequency of inverter	25kHz
f	ac line frequency	60Hz
Tr1/Tr1/Tr3	multit-pulse transformer	1.5kVA
Rec1/Rec2/Rec3	rectifier module	FUJI 6RI30E-060
S ₁ -S ₆	IGBT	IXYS FII 50-12E
IPT	inter-phase transformer	100V/300VA

VI. SIMULATION AND RESULTS

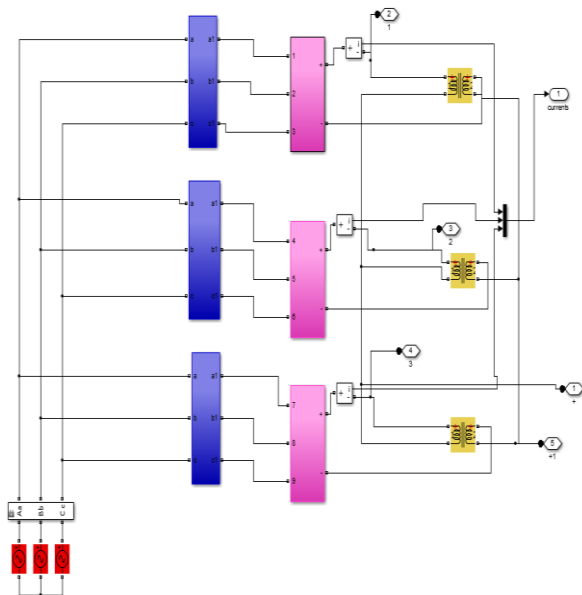


Fig6. 18 pulse converter simulation model

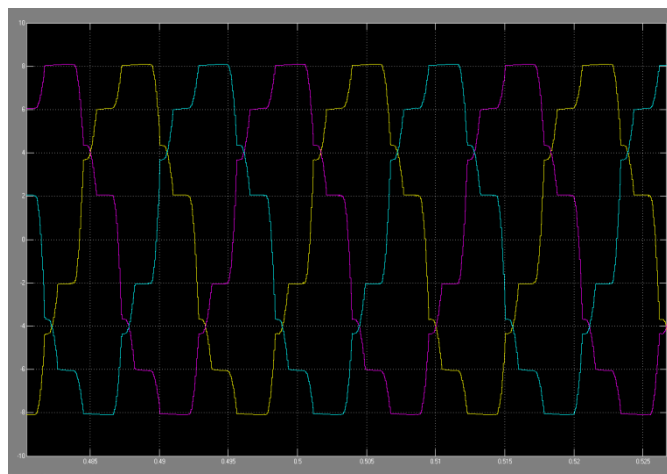


Fig7. AC Line Current waveform

TOTAL HARMONIC DISTORTION
Total Harmonic Distortion of AC Line Current of the 18 pulse converter System is very high i.e., 15.18%

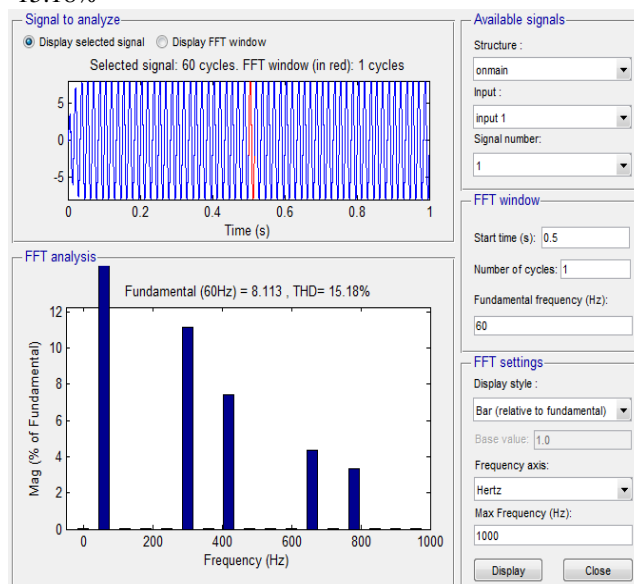


Fig 8. THD of 18 Pulse converter

To Reduce these total harmonic distortion and maintain quality in ac line current we are using 3-phase inverter system with pulse width modulation technique.

3-PHASE INVERTER SIMULINK MODEL

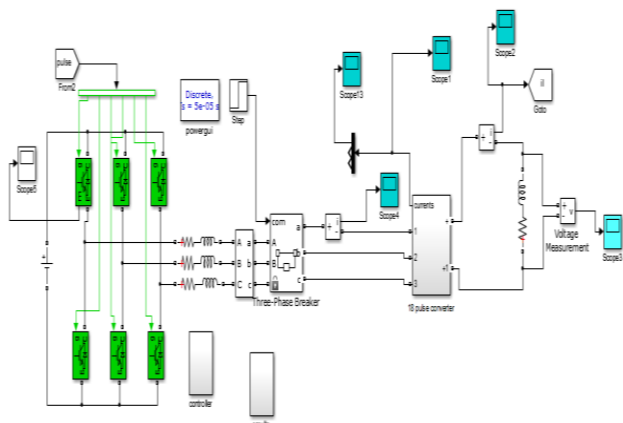
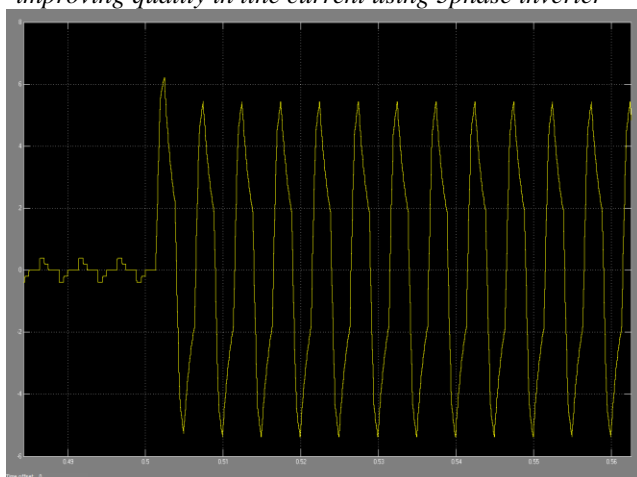
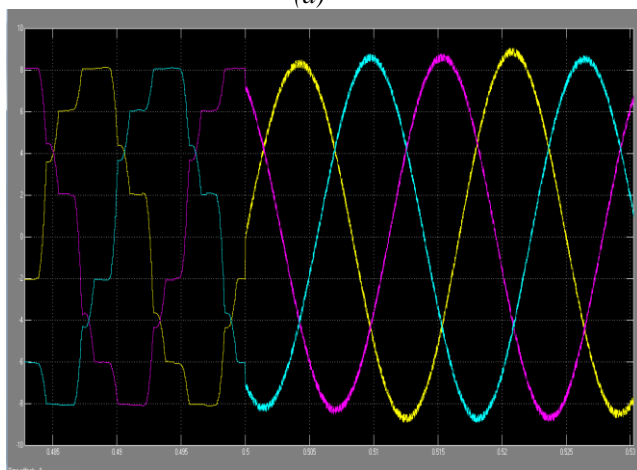


Fig 9. Simulink model of 18 pulse converter for improving quality in line current using 3phase inverter



(a)



(b)

Fig 10.(a) Injecting current i_{x1} (b) Line Current after injecting currents i_{x1} , i_{x2} , i_{x3}

TOTAL HARMONIC DISTORTION

The THD of 18-pulse converter system by using 3-phase inverter with pulse width modulation Technique is 2.26 % shown in the fig.11

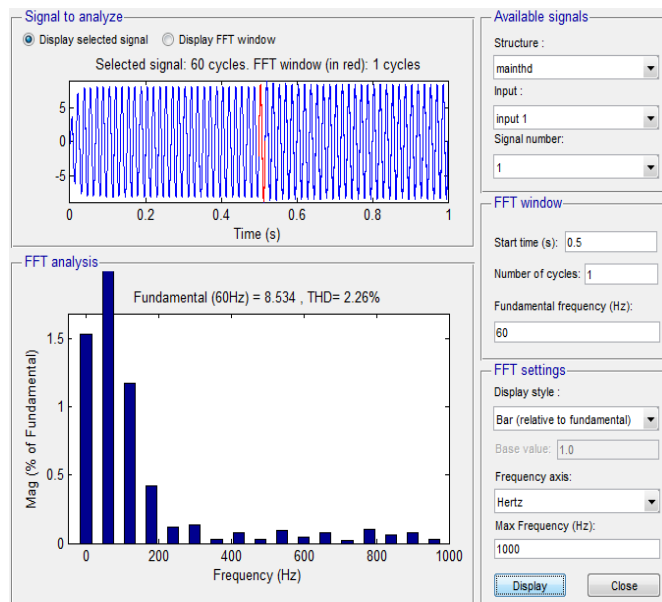


fig 11. THD of Proposing method

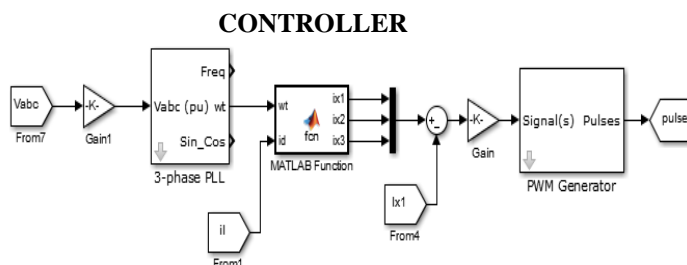


Fig 12. Controller and Pulses generating simulink to IGBT

In this controller the pulses pwm generator having the time period for the generating and send the signals to the IGBTs. The time period are placed in the MATLAB function in the form of code. The Comparator is used to compare the currents taken from the Matlab Function i_{x1} , i_{x2} , i_{x3} and the Form4 having the 18pulse Inverter i_{abc} Current. These two current signals are compare and sends to the PWM Generator through Gain. The PWM Generator Generate the triggering pulses with the respect timings of the IGBTs.

EXTENSION

Previously, the controller of the project was used is Pulse width modulation Controller to give the triggering pulses of IGBT's but in this Extension we use Hysteresis Controller to give pulses of IGBT's .

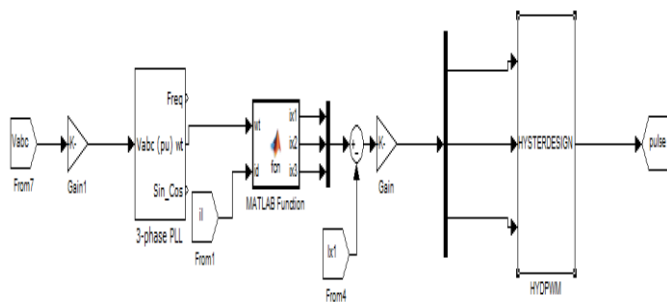


Fig 13. Controller and pulse generating using Hysteresis.

TOTAL HARMONIC DISTORTION AFTER USING HYSTERESIS

After using hysteresis technique the FFT window shows the harmonics and the total harmonic distortion reduced to 1.87%

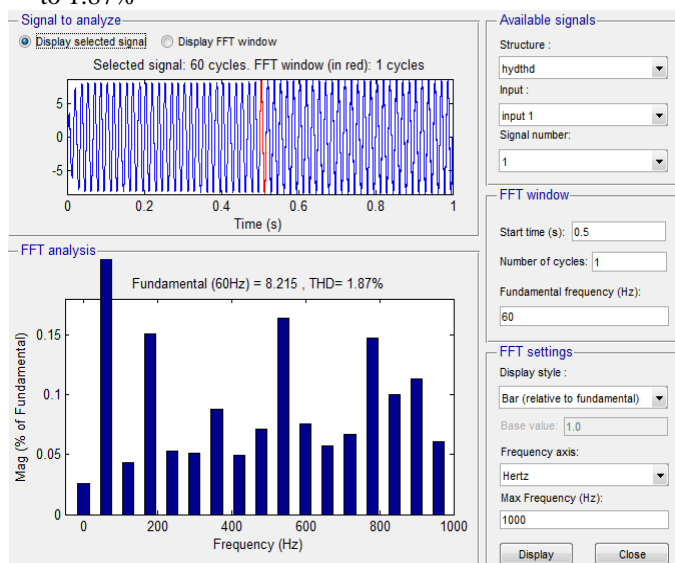


Fig14. THD Using Hysteresis controller

COMPARISON OF THD VALUES OF THE AC LINE CURRENTS USING DIFFERENT CONTROLLERS.

S.no	Controller	THD values in %
1.	No controller	15.18 %
2.	Pulse width Modulation	2.26 %
3.	Hysteresis	1.87 %

Table 1 comparison of THD values

VII. CONCLUSION

In this paper we used 18-pulse converter system to reduce total harmonic distortion and to improve quality in line current we are using a 3-phase inverter system with PWM and Hysteresis Controller. Therefore we get sinusoidal line current and THD is reduced from 2.26% to 1.87%.

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