High Efficient Three Phase Harmonics Elimination System for Induction Motor

K.Vinay kumar

Abstract : Symphonious relief may be a key issue in mechanical and conjointly business drive applications. The wide utilization of non-direct hundreds causes vital power quality debasement up to the mark dissemination systems. The planned strategy is made to agitate sounds in grid connected (GC) mode, and within the islanded or freelance (SA) methodology of task, wherever the elemental target is to expel the harmonic from the framework current and also the point of common coupling (PCC) voltage. The arranged position of the agreeable decline unit deals with the work of a novel controller structure that utilizes the sounds measure inside the d-q reference outline. Inside the arranged administration figuring, the predetermined live of change for consonant is made plans to fulfill the blend amicable curving. a total amusement indicate is made with a chose complete objective to watch the execution of the arranged consonant compensator. The arranged methodology is also existent by interfacing acceptance machine to the yield and execution of the engine is analyzed using Matlab/Simulink programming.

Key Words: Total harmonic Distortion, Point of Common Coupling, Induction Motor Drive, Grid Connected Mod

I. INTRODUCTION

Power electronic gadgets have clothed to be copious these days as a result of their skills for precise method management and vitality funds advantages. In any case, they in addition bring disadvantages to electrical dissemination frameworks [1]: sounds square measure a developing pressure within the employer of electrical systems nowadays. The closeness of symphonious in electrical structures infers that blessing and voltage rectangular measure contorted and stray from bending waveforms. Symphonious streams square degree resulting from nonlinear weights identified with the flow structure. A stack is professed to be nonlinear once the prevailing it draws in does not have a almost equivalent to waveform in light of the truth that the offer voltage. The surge of symphonic recurring styles via the gadget impedances ultimately causes voltage reshaping inside the scattering structure [2-5]. equipment which includes power digital circuits rectangular degree everyday nonlinear weights. Such hundreds square measure a first rate deal of increasingly more no-restriction by using and huge mechanical, commercial enterprise, and character agencies and their size of the combo stack is growing unfaltering. Symphonious streams increase the rms go with the flow in electric structures and rot the accessibility voltage fine. They make bigger the electric framework and apparently damage the gadget [6]. they will annoy usual movement of contraptions and addition running costs. signs of perilous symphonic dimensions fuse warming of transformers, vehicles and connections, warm weaving of careful devices and rule problems with treated devices. what is more, the life of different gadgets is diminished through raised running temperatures [7-9].In a power shape, acknowledgment automobiles communicate to the maximum crucial a chunk of the pile and rectangular measure inexactly utilized as a locale of later, commercial enterprise and individual applications. when the workplace structure receives tainted with sounds, the errand traits of acknowledgment vehicles rectangular degree impacted beginning. The use of induction motors (IMs) square measure increasing step by step in business space for top power applications [10]. The principle favorable circumstances of IMs square measure rough out development, straightforward support, less value and adequately high productivity, etc. The projected Harmonics elimination method is formed to trot out harmonic in grid connected (GC) mode, as well as within the islanded or freelance (SA) technique of task, wherever the first target is to expel the harmonic from the network current and therefore the point of common coupling (PCC) voltage. The anticipated methodology gives 2 essential responsibilities. to begin with devotion is that the anticipated region of the sounds exchange unit to do synchronous consonant compensation inside the system present day and therefore the p.c voltage [11]. the second one commitment is that the utilization of compelling counts to recognize and shape for the sounds. utilizing computationally amazing counts lets in extra abilities to be finished through the consonant pay unit with a minimum endeavor introduced controller [12]. The consonant diminishment unit related in relationship to the street has valuable job of substantially less power usage. At long shutting the symphonic transfer strategy with acknowledgment motor power is anticipated and springs concerning respected for stator loop present day, and power and speed.

II. PLACEMENT OF HARMONIC COMPENSATION UNIT IN MICROGRID SYSTEM

In regular methods the arrangement harmonic diminishment units area unit place at the network aspect, as appeared in Fig.1 wherever the goal is to create the road electric resistance at the consonant return as high as may be expected beneath the circumstances. From Fig.1,

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Dr.K.Vinay kumar, Asst Professor, SVS Institute Of Technology Telangana, India

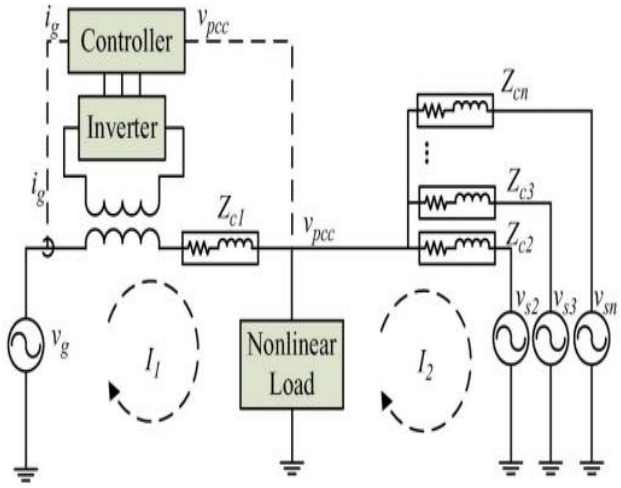

Fig.1. Conventional harmonic compensation method.

the work conditions for the overall framework for harmonious elements will be composed as takes after:

$$I_{n_1} Z_{n_{c1}} + V_{n_{\text{inj}}} = V_{n_{\text{pcc}}} \quad (1)$$

$$I_{n_2} Z_{n_{c2}} = V_{n_{\text{pcc}}} \quad (2)$$

Where $V_{n_{pcc}}$, $V_{n_{inj}}, I_{n_1} Z_{n_{c1}}$ represents the ordinal harmonious PCC voltage, infused voltage, grid current, and coupling resistivity, separately. The lattice current will be communicated as

$$i_g = I_1 = \sum_{n=1}^{N} A_{n_1} \sin(n\omega t + \theta n) \quad (3)$$

The infused harmonious voltage in arrangement with the framework is like the grid current, to Illustrate,

$$V_{n_{\text{inj}}} = k_n I_{n_1} \quad (4)$$

where gain of knis known as the coupling resistivity and therefore the electrical device turns proportion. Visible of (1) and (4)I_{n_1}can be determined as

$$I_{n_1} = \frac{V_{n_{\text{pcc}}}}{Z_{n_{c1}} + k_n} \quad (5)$$

The pay unit drives voltage harmonic to create the network current sounds free; still, this voltage harmonic twist the PCC voltage. additionally, amid the reserves technique of task, the framework branch is detached influencing the pay unit to sit down out of substances.

The projected position for the harmonic infusion unit during this exploration is that the circulated age aspect, as appeared in Fig.2. For this version, the goal of the amicable pay unit is to make the resistivity within the wellsprings of the microgrid viewpoint as subsequent to no as possible to contain this sounds an all-encompassing way from the gadget attitude. on these strains, if the go phase voltage is sans symphonious, the % voltage can push toward reworking into sounds free. furthermore, whilst the lattice is withdrawn the symphonious decline unit will continue on in interest.

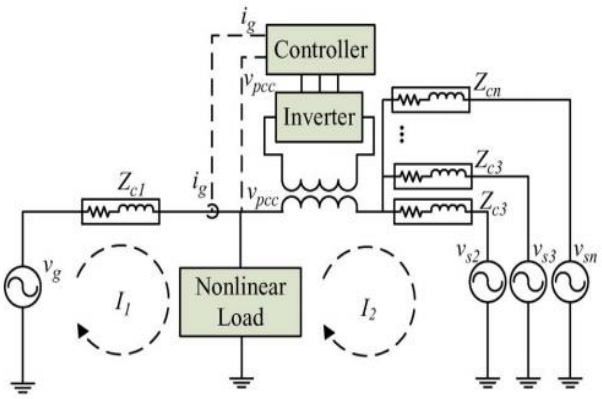

Fig.2. Proposed harmonic compensation method.

The unit makes the PCC voltage symphonious free through giving consonant voltage at its yield that neutralizes the music results from the voltage drop at the coupling impedances away SA task. For the consonant parts, the condition for work present day I1 and I2 might be composed as pursues:

$$I_{n_1} Z_{n_{c1}} = v_{n_{\text{pcc}}} \quad (6)$$

$$V_{n_{\text{inj}}} + I_{n_2} Z_{n_{c2}} = V_{n_L} \quad (7)$$

The unit makes the PCC voltage harmonious free by giving consonant voltage at its yield that neutralizes the harmonic comes concerning as a result of the drop at the coupling impedances away reserves activity. For the harmonious elements, the condition for work current I1 and I2 will be composed as takes after:

From (6) remarkably if I_(n_1)is shut zero then V_(n_pcc)will be close to zero furthermore. In writing, the inverters within the microgrid ar controlled to share this sounds with the top goal that the harmonics within the PCC will be diminished. This approach will facilitate in appropriating the sounds creation over the sources, but it cannot defend that the combination consonant distortion(THD) on the machine contemporary or on the percent voltage is at a lower put as course as viable. Having the compensation unit near the percent enables a clear access to the p.c voltage and on this manner the device cutting-edge, no matter the fact that the association can be unthinkable for one-of-a-kind resources due to the land unfurl of the microgrid. round then, the repayment unit will anchor the consonant loose structure cutting-edge and percent voltage by means of diverting the sounds to the issue of interchange resources, which may additionally impart the symphonious to progress through the strategies gave.

III. CONTROLLER STRUCTURE

The general sq. define of the controller structure is appeared in Fig.3. The sq. define for the sounds finish unit is appeared in Fig.4. The harmonic disposal unit basically incorporates of 2 vital squares music estimation piece and sounds mixture sq.. successful and practical symphonious estimation and in this manner the consonant complete procedures, advised and painted in Fig.four, ar utilized for

stage recognizable proof and consonant 1/2 estimation. because of the reality the nearness of the symphonious influence the PLL exactitude, the principle organize is utilized to get rid of the consonant from the tried grid hail guaranteeing exactitude of the PLL. the second dimension gives fast and exceptional sounds estimation because of the reality the PLL produces a specific degree. The sounds implantation turn away, this deals with the live of consonant mixture through the symphonious compensator.

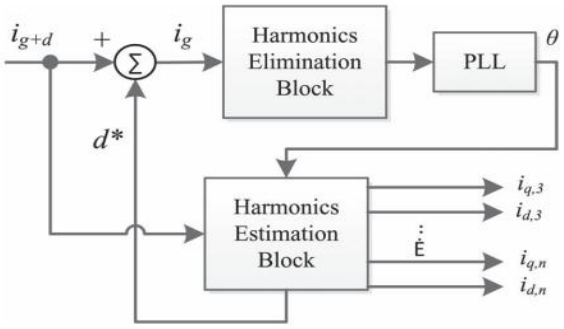

Fig.3. Overall, harmonic compensation block.

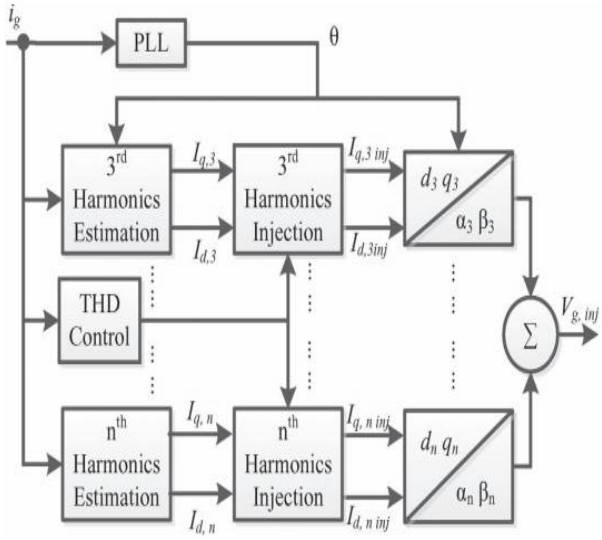

Fig.4. Harmonics elimination block diagram

The grid current and the PCC voltage are bolstered to the phase locked look (PLL) block. The PLL bolt isolates the degree of the focal half. round then, the usage of the PLL yield, the third, 5th. . . ordinal symphonious of these signs and symptoms ar assessed. The dq parts of the assessed sounds ar sent to the consonant aggregate sq. to determine out what volume voltage on the decided consonant rehash must be limited to be implanted into the street in lightweight of the blunder among the genuine and reference.

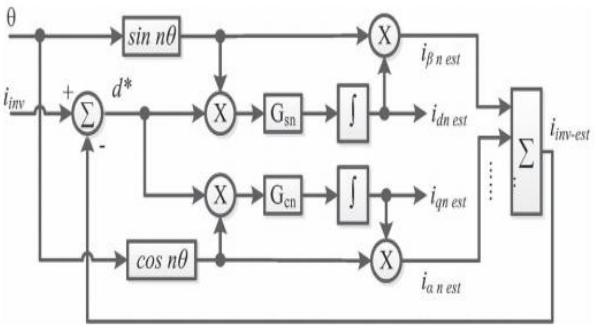

Fig.5. Harmonics estimation block

The harmonics estimation block is used to measure the level of sounds must were implanted from the compensator. The square outline for consonant estimator is respected in Fig.5. The sounds estimation is done in gentle of the area gave by utilizing the PLL square. The shut circle gadget gives the assessed voltage in both αβ and dq pivoting reference characterize for imperative, and in addition sounds portions. The transfer function for the harmonics estimation block can be composed as

$$\frac{\hat{V}_{d,n}(s)}{V_{d,n}(s)} = \frac{0.5G_{\text{sn}}}{s + 0.5G_{\text{sn}}} \quad (3.8)$$

As indicated by IEEE 519, the individual consonant segments ought to be under 3% and the THD ought to be under 5% to guarantee control quality. The reference estimation of THD in the THD control hinder, as appeared in Fig. 3.4, ought to be set by this prerequisite. At the point when the general harmonic is diminished beneath the suggested THD, the measure of the infusion for individual harmonics part is kept consistent. This likewise guarantees the system to work in stable condition.

Within the sight of no integer harmonics or some other unsettling influences the deliberate current signal appeared in Fig.3, can be communicated as

$$i_{g+d} = i_g + d \quad (9)$$

where ig is the network current and d is the disturbance. The evaluated aggravation can be communicated as

$$\hat{d} = i_{g+d} - \hat{i}_g = i_g + d - \hat{i}_g = err + d \quad (10)$$

where, ig is the evaluated estimation of the current and err is the estimation error. The estimation error is relied upon to be significantly littler than the unsettling influence (err << d). which is weakened essentially by the filters of the estimators (see Fig. 3.5). In this way, $\hat{i}_g$ which is attenuated significantly by the filters of the estimators (see Fig. 3.5)? Thus, $\hat{i}_g$ can be described as

$$\hat{i} = i_{g+d} - \hat{d} = i_g + d - err - d = i_g - err. \quad (3.11)$$

Since err will go to zero after two or three cycles,, $\hat{i}_g$ move toward becoming mistake free. In this manner, PLL won't be influenced by the nearness of non integer sounds.

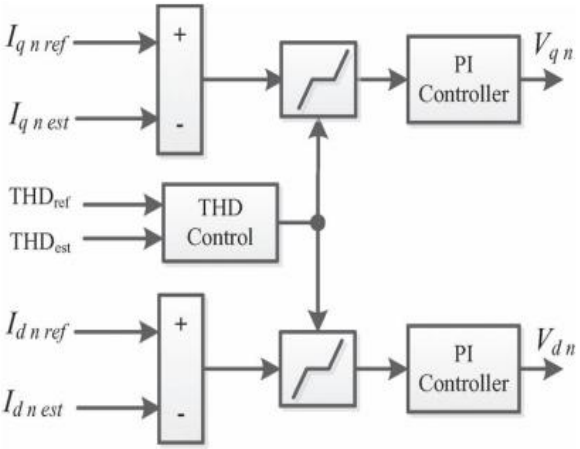

Fig.6. Harmonics injection unit

IV. CONTROLLER OPERATION

Fig.5 speaks to the square graph of the song imbuement unit, wherein the pined for proportions of consonant are known as in dq reference layout. wished THD degree is in like manner given as a wellspring of point of view into the controller square. The THD manipulate piece gets the accumulated THD and proper THD of the system current or voltage at p.c. The THD reference is typically set with the aid of the specified power fine. The d and q portion of the symphonious current or voltage ought to be lessened to discard sounds from the framework. This plan guarantees that without an express consonant, the reimbursement unit might not implant any more symphonious to the gadget (see Fig.6). The PI controller is in price of diminishing the symphonious quantities underneath past what many would remember viable. After the THD level reaches beneath quite far, the PI controller yield modify and maintains to infuse the express percentage of symphonious. The circulate outline of the general symphonious quit technique of machine contemporary and p.c voltage is given in Fig.7

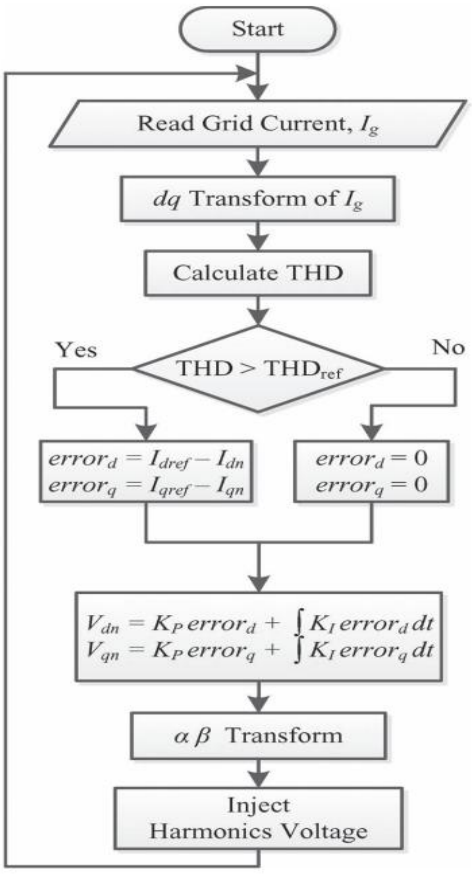

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Fig.7. System Flow Diagram

The consonant reverberation condition may happen because of the capacitors associated with a microgrid. The oversee of symphonious reverberation might be performed by means of tuning the virtual impedance inside the microgrid controller. growing the computerized impedance will bring about limiting the consonant advanced buoy. To characterize a PI controller for consonant pay, an anticipated show for the indistinguishable contraption is derived in dq pivoting reference outline, as demonstrated graphically in Fig.8. The differential conditions for the systems can be composed as

$$L\frac{di_d}{dt} = -Ri_d + v'_{dh} + \omega Li_q - v_{dh} \quad (12)$$

$$L\frac{di_q}{dt} = -Ri_q + v'_{qh} + \omega Li_d - v_{qh} \quad (13)$$

In the Laplace domain (3.12) and (3.13) can be written as

$$sLI_d = -RI_d + V'_{dh} + \omega LI_q - V_{dh} \quad (3.14)$$

$$sLI_q = -RI_q + V'_{qh} + \omega LI_d - V_{qh} \quad (15)$$

The transfer function can be expressed in terms of the PI controller (kp,ki) and harmonics estimation gain, G, as shown in Fig.5, as

$$V'_{xh} = \frac{k_p s + k_i}{s}\frac{G}{s+G} i_x \quad (16)$$

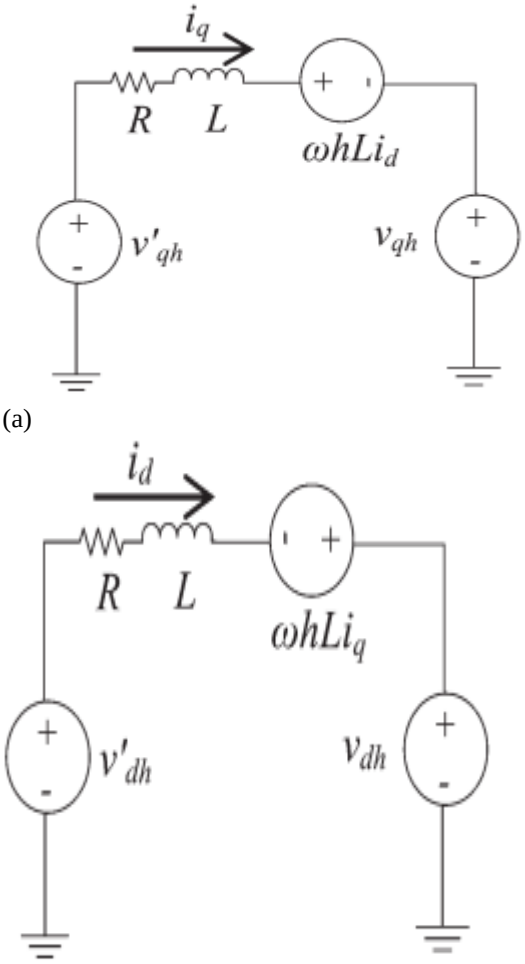

Fig.8. Equivalent (a) q component (b) d component circuit for PI controller design

Substituting V'dhandV'qhfrom (16) to (14) and (15) we would obtain

$$sLI_d = -RI_d + \frac{k_p s + k_i}{s}\frac{G}{s+G} i_d + \omega LI_q - V_{dh} \quad (17)$$

$$sLI_q = -RI_q + \frac{k_p s + k_i}{s}\frac{G}{s+G} i_q - \omega LI_d - V_{qh} \quad (18)$$

From (17) and (18), the characteristics equation for the system can be written as

$$\left(sL + R\frac{k\left(s+\frac{k_i}{k_p}\right)}{s}\frac{G}{s+G}\right)^2 + (\omega L)^2 = 0 \quad (19)$$

In any case, the gain k is constrained by accessible inverter dc bus voltage. On the off chance that the gain is too high, it will soak or over-load the inverter of the repaying unit. Along these lines, appropriate estimations of k should be resolved to guarantee steady and legitimate activity of the remunerating unit.

V. MATLAB/SIMULINK RESULTS

Case 1: Grid Connected Mode

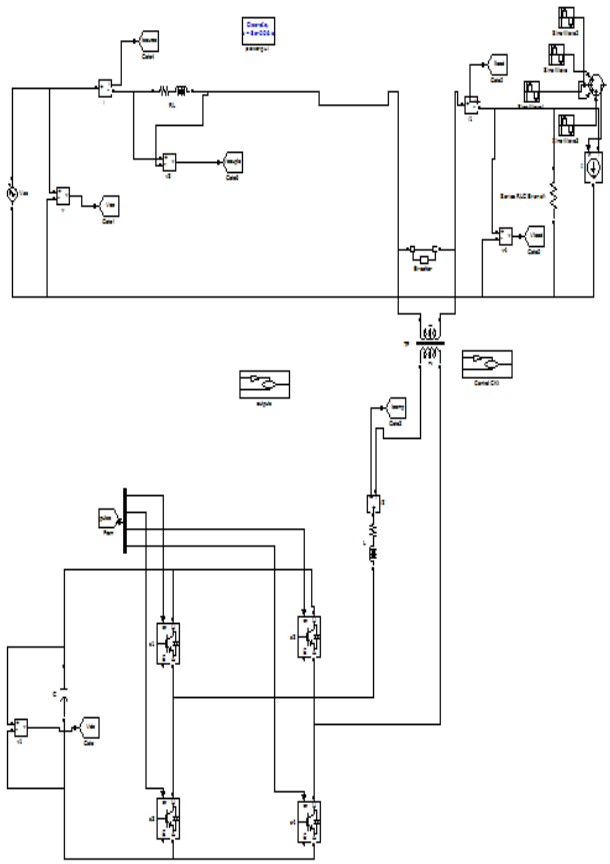

Fig.9. Matlab/Simulink Circuit for Harmonic compensator with grid connected mode

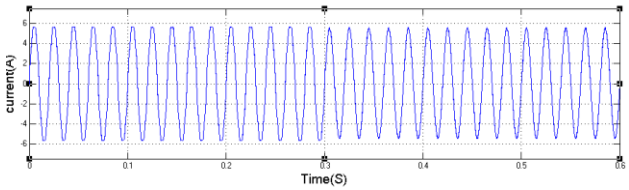

Fig.10. Grid current before and after harmonics elimination in GC mode

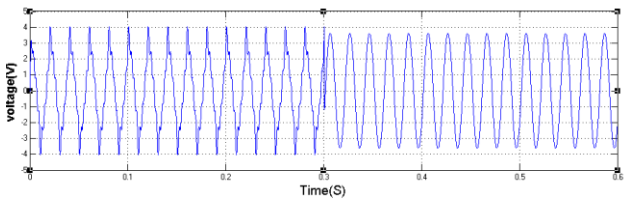

Fig.11. Voltage across coupling impedance of the line before and after harmonics elimination (GC)

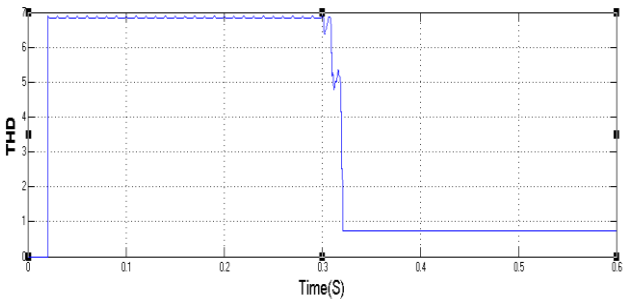

Fig.12. THD in grid current in GC mode as controller adjusts the compensation level.

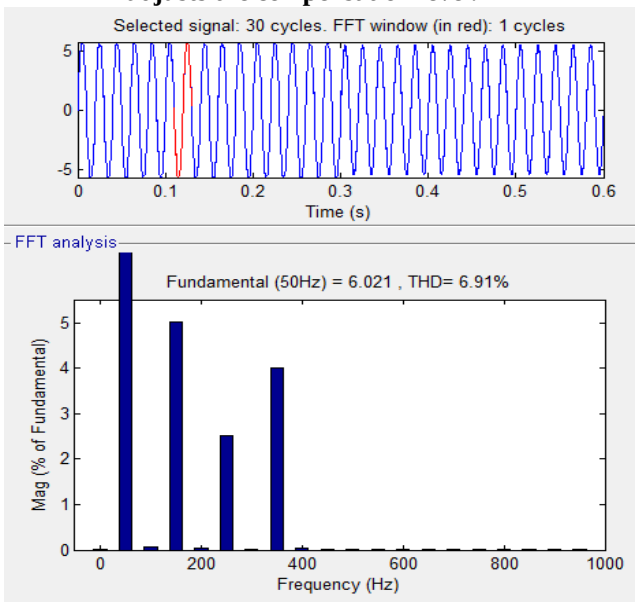

Fig.13. FFT analysis at Grid connected mode

Case 2: SA Mode

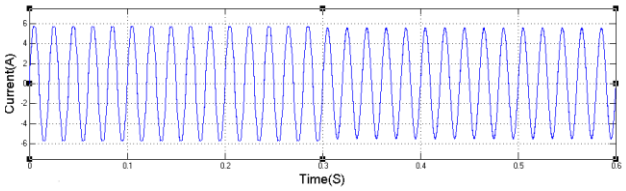

Fig.14. Grid source current in SA mode of operation

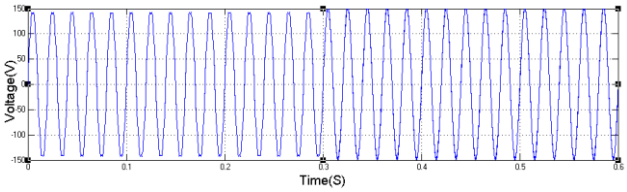

Fig.15. Voltage across coupling impedance of the line at SA mode

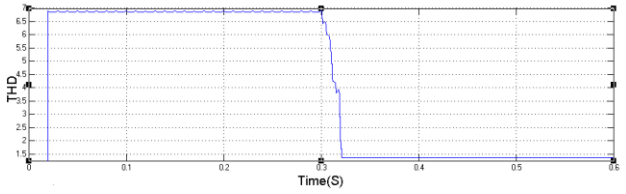

Fig.16. THD in the PCC voltage at SA mode.

Case 3: Inter harmonic Injection

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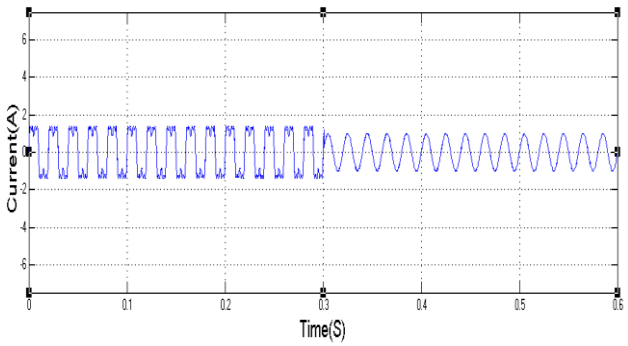


Fig.17. Interharmonic compensation for the grid current

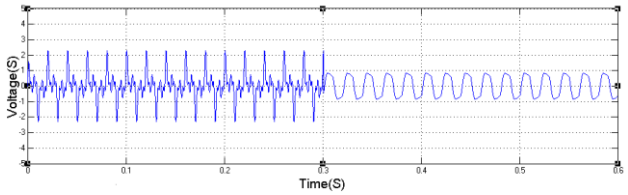


Fig. 18.Interharmonic compensation for the Voltage Couple

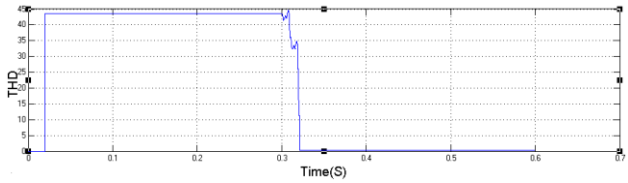


Fig.19. THD in grid current with Inter Harmonic

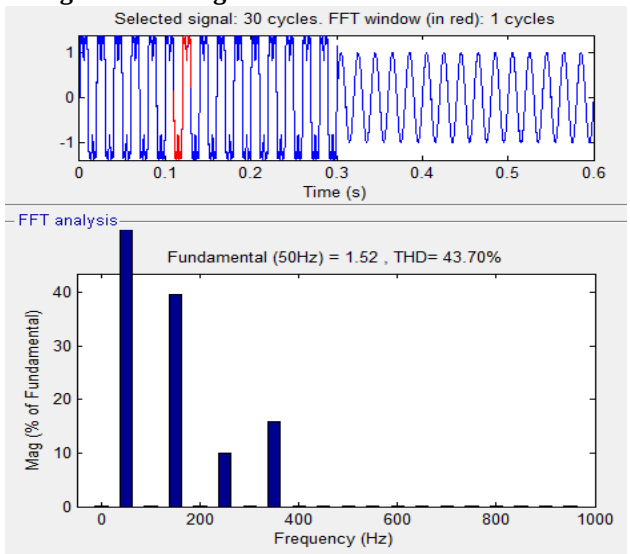


Fig.20. FFT analysis before applying interharmonic compensation for the grid current

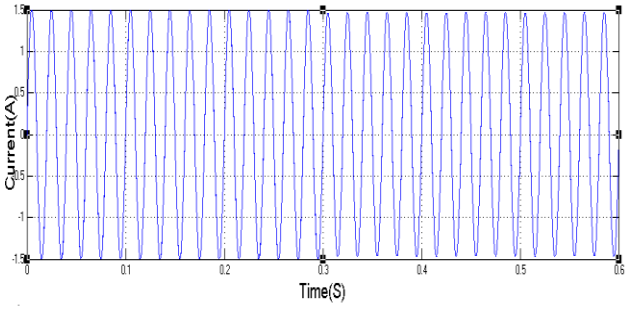


Fig.21. Current source before the compensation is applied.

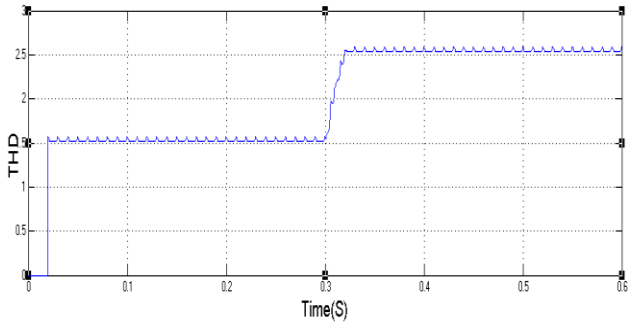


Fig.22. THD in grid current before the compensation is applied.

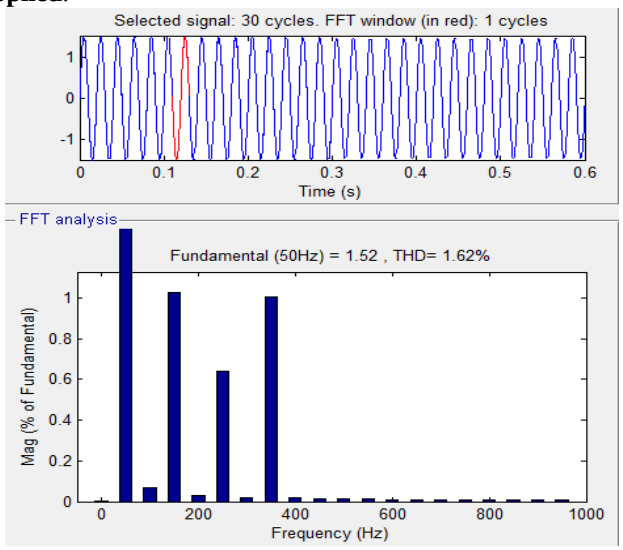


Fig.23. FFT analysis of the critical load current before the compensation is applied.

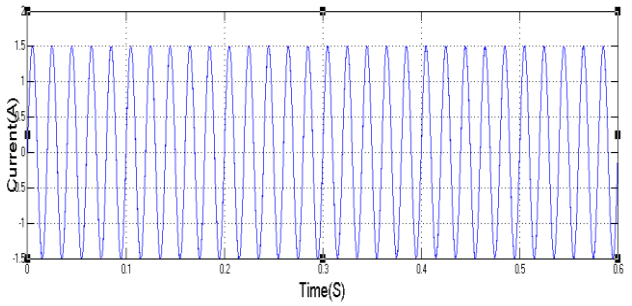


Fig.24. Current source after the compensation is applied

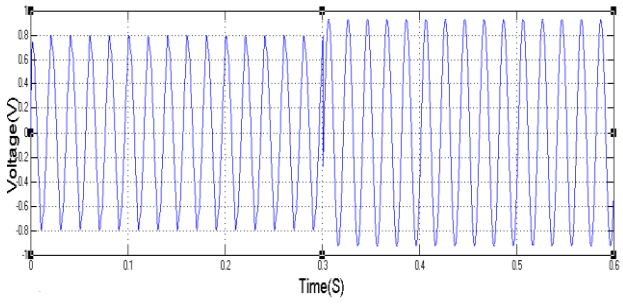


Fig.25. Voltage across coupling impedance of the line after compensation applied.

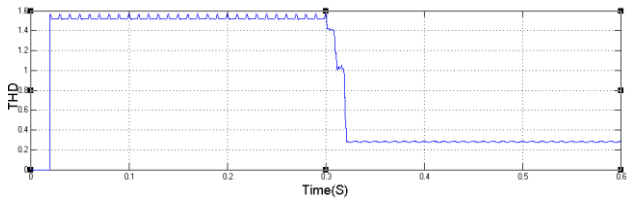


Fig.26. THD in grid current after the compensation is applied.

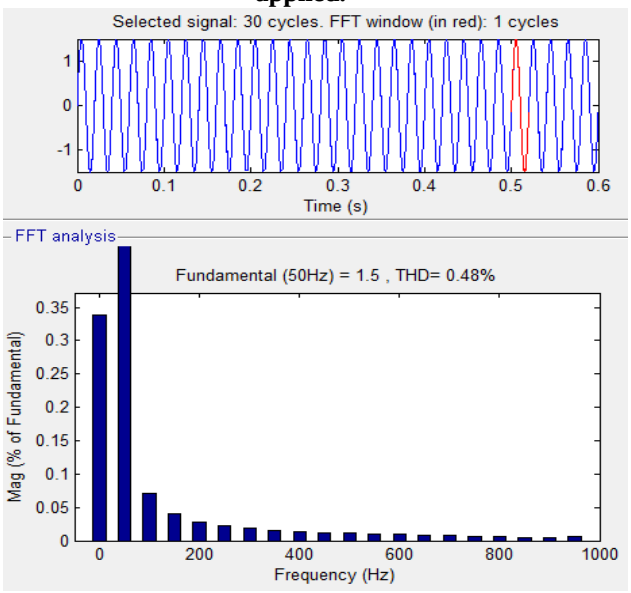


Fig.27. FFT analysis of the critical load current after the proposed compensation method is applied.

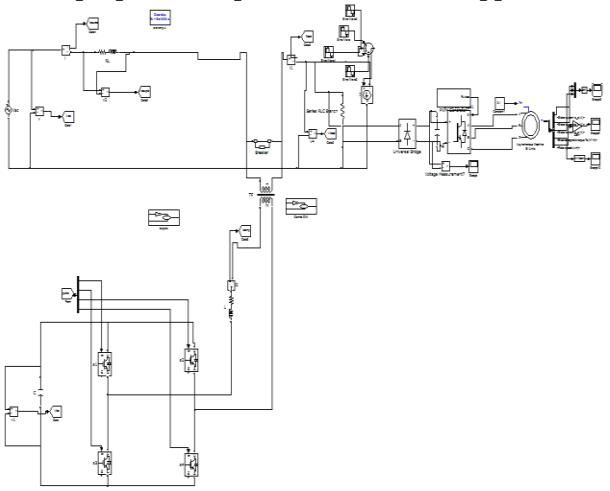
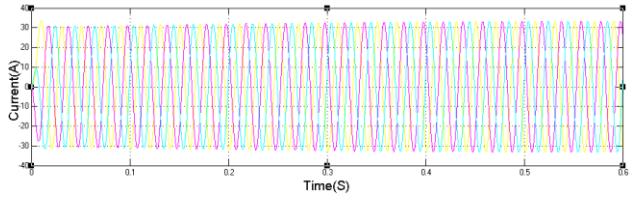
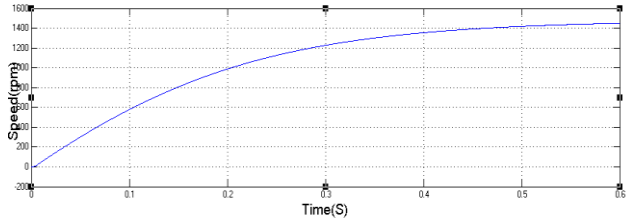


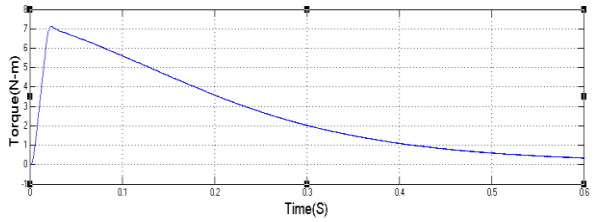
Fig.28. Matlab/Simulink Circuit for Harmonic compensator with SA mode single phase Induction motor Drive



Stator Current



Speed



(c) Electromagnetic Torque

Fig.29.Simulink waveform for Harmonic compensator with SA mode single phase Induction motor Drive Stator Current, Speed and Torque.

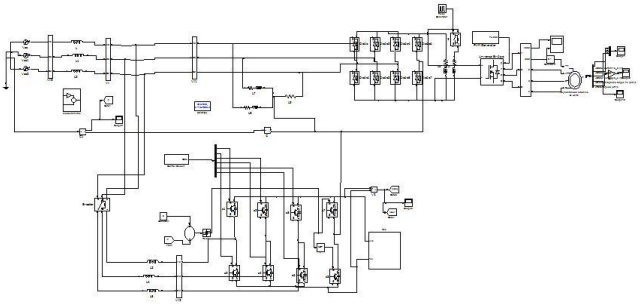
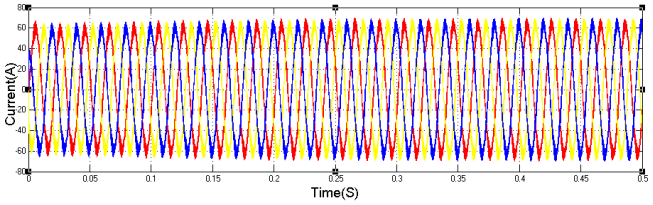
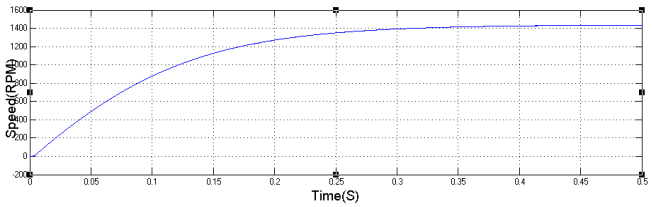


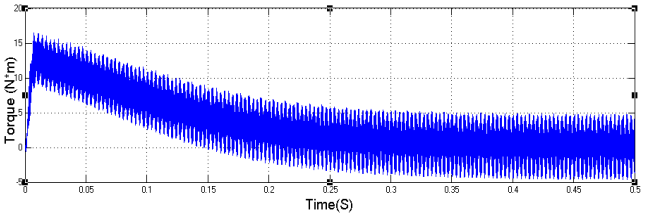
Fig.30. Matlab/Simulink Circuit for Harmonic compensator with SA mode three phase Induction motor Drive



(a) Stator Current



Speed



(c) Electromagnetic Torque

Fig.29.Simulink waveform for Harmonic compensator with SA mode Three Phase Induction motor Drive Stator Current, Speed and Torque.

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VI. CONCLUSION

Another strategy for guaranteeing power quality both in the grid current and PCC voltage has been proposed on this paper. Consonant flows increase the rms go with the flow in electrical frameworks and debilitate the supply voltage satisfactory. The region of the sounds decline unit became disposed of the consonant inside the device cutting-edge and the % voltage, too. The proposed function of the symphonious lower unit coordinates the usage of an remarkable controller structure that makes use of the consonant diploma within the d-q reference define. A possible and succesful technique is used to measure the symphonious within the line. The proposed implants a voltage to regulate the sounds within the structure and decrease the THD to wished dimensions. The adequacy of the proposed machine is affirmed thru multiplication consequences. This symphonious reimbursement method can be prolonged by means of interfacing Induction motor power, on this the stator modern-day, speed and Torque are believed to be higher.

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