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Study of Power Quality Improvement using LS – UPQC in distribution Networks

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ABSTRACT

This paper presents a new converter transformer with Active Compensator (LS - UPQC) to provide shunt and series compensation in the power system networkin order to eliminate the power quality problems. The power network delivers power supply to dissimilarclassesof loads like rectifier fed motor drives, uninterruptible power supplies etc. NCT embraces an unmistakable wiring game plan at the optional side joining two windings in particular as auxiliary broadened winding and auxiliary basic winding. In the middle of these two winding an interfacing point is accessible to associate the remunerating gadgets. The shunt and arrangement dynamic channel together called as LS - UPQC are associated at the association highlight decrease the current and voltage quality and to keep up the sinusoidal conduct of the approaching force supply to the heap at the force framework organization. Introduction of NCT with LS - UPQC is a lot of successful when identified with bygone shunt dynamic force sifting (SAPF) technique.

1. Introduction

An electrical framework frequently conveys capacity to the shoppers having different sorts of burdens, including nonlinear burdens, for example, single-stage or three-stage thyristor converters, diode rectifiers and UPS. These nonlinear burdens may perhaps deliver sounds and hence it makes the framework to be lopsided and furthermore devour receptive force. On the off

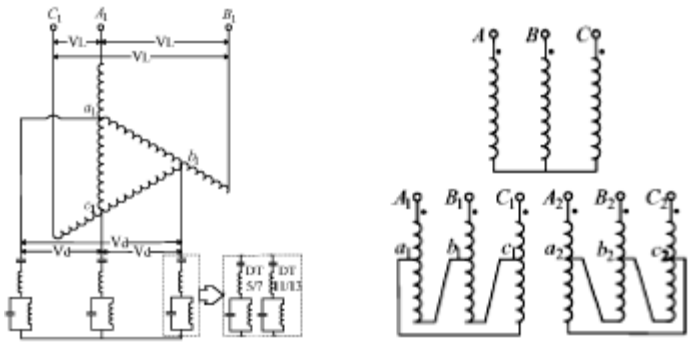
chance that an appropriate pay isn't set up the force nature of ac frameworks can be crumbled.The time that the power electronic component has a great impact in the power system network to improve its performance at that situation the quality problems becomes is the major concern for the network engineers. The interface of intensity gadgets segments may create sounds and require receptive force. Likewise the sorts and phases of the twists may shift with the activity states of the scattered age units and the heaps; in this manner, a viable remuneration framework is needed to adjust the force quality

The use of traditional compensation methods such ascapacitor banks and passive power filters (PPF) gives rise to harmonic propagation, i.e., harmonic voltage amplification due to resonances created between line inductances and capacitance exist between the line to line and line and earth. Therefore we need a different solution methods to compensate the problems at the same time it will not create the resonance issues between the systems.By and large in a HVDC frameworks converter transformer are utilized in the rectifier and inverter station. The symphonious parts from the nonlinear burden will have the way to stream unreservedly in the windings of the transformer at the optional just as the essential side, which diminishes the existence season of transformer and it likewise carries PQ issues to the dispersion organization and to the force supply framework [9]. A New Converter Transformer receives an alternate wiring plan to interface the shunt dynamic channel at the optional side with the goal that it gives a functioning answer for the current quality issues like helpless force factor, load symphonious flows, load unbalance and so forth This technique can forestall a symphonious and receptive force divide from streaming uninhibitedly into the transformer's essential winding and can consequently tackle the PQ issues of the force supply framework adequately. [10].

The voltage quality issues that happen on the supply side, for example, voltage lists/swells, gleam, voltage unbalance and music, are another serious issue. We need to have an arrangement pay framework, which is generally called a functioning arrangement channel, to make up for this. We need to keep up both voltage and current quality to accomplish a sensible nature of intensity in the dispersion organization. This can possibly happen when shunt and arrangement pay gadgets are given together in the n circulation

2. New Converter Transformer

Fig. 2 (b) indicatesthe brand new converter transformer and the corresponding inductive filtering mechanism, indicates the wiring association of the transformer, and its secondary winding implements the extended-delta wiring. To simplify our discussion, the winding of A_i-a_i, B_i-b_i, Ci-c_i (i=1, 2) is known as secondary extended winding, and the winding of a_1-b_1, b_1-c_1, c_1-a_1, a_2-c_2, b_2-a_2, c_2-a_2 is known as secondary not unusual place winding. Fig 2(a) indicates the association of inductive filters. As may bevisible from (a),a fauceton the connecting factor of extended winding and not unusual place winding is hooked up with double-tuned (DT) filters.



(a) (b)

Fig 1Wiring Manner of NCT

Self-Coupling Action. The self-coupling movement of the secondary extended winding and the not unusual place winding of the brand new converter transformer is much like the collection winding and the not unusual place winding of the automobile transformer.

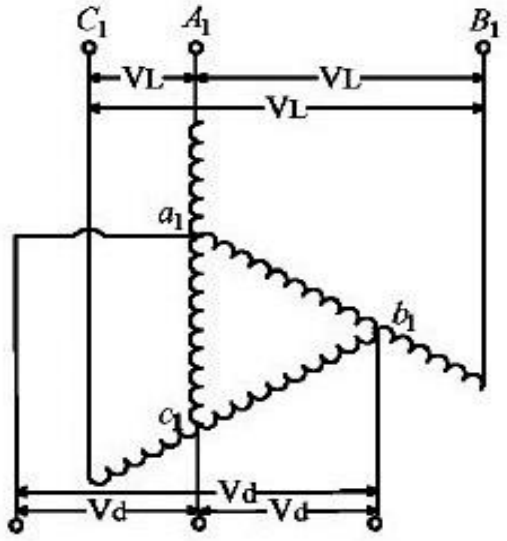


Fig.2.Winding arrangement of NCT

According to Fig. 3, the output voltage is V_L, the voltage of the secondary not unusual place winding is V_d and the voltage of the secondary extended winding is V_e then the voltage phasor drawing has been establishedwith inside the Fig 4

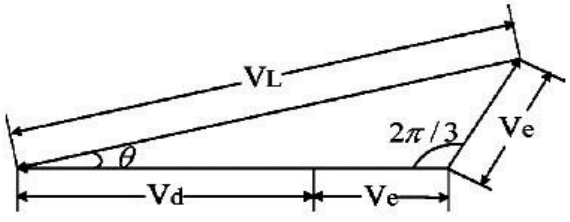


Fig. 3. Voltage phasor illustrationfor NCT Secondary Side

The cosine rule states that the output line-voltage can be articulated as follows:

$$V_L^2 = (V_e + V_d)^2 + V_e^2 - 2V_e(V_e + V_d)\cos\frac{2\pi}{3} (1)$$

Then, the voltage of the secondary prolonged Winding can be deduced as follows:

$$V_e = -\frac{V_L^2}{3} + \sqrt{\frac{V_L^2}{3} - \frac{V_d^2}{12}} \quad (2)$$

The secondary extended and not unusual place winding of the brand NCT is in electromagnetically coupled, that'sjust like that of vehicle transformer collection and not unusual place winding. When the secondary extended and the not unusual place winding keeps the magnetic pressure equilibrium, we will get the subsequent relation:

$V_e I_e = V_d I_d$(3)

in which Ie and I_d are the RMS value of current of the secondary prolonged and common winding respectively.

Fig. 4, shows that the current Ie of the drawn out winding is equivalent to the yield current , and its electromagnetic limit can be communicated as follows:

$$S_e = 3V_e I_o$$

(4)

Meanwhile, the output capacity can be expressed as follows:

$$S_o = \sqrt{3} V_L I_o$$

(5)

Then, the ratio coefficient can be obtained as follows, which is used to analyse the material utilizing ratio of the transformer:

$$\alpha = \frac{S_e}{S_o} = \frac{\sqrt{3} V_e}{V_L} \quad (6)$$

Where α is the ratio coefficient of new converter transformer.

Inductive Filtering Mechanism.

The unmarried-segmentversion of the brand new converter transformer is proven in Fig. 5. The unmarriedsegmentversion is used to examine the inductive filtering mechanism. In this figure, the harmonic contemporarysupply is characterized as I_h, which is likewisecharacterizes the harmonic contemporary of the secondary extended winding. The harmonic contemporary of the number one winding and econdary not unusual place winding is characterized as I_{h1} and I_{h3} correspondingly. The harmonic contemporary $I_h$with inside theextended winding will result in the harmonic currents I_{h1} and I_{h3} with inside thenumber one winding and not unusual place winding of the transformer. These currents are used to stability I_h.Permitting to ampere turns method, the following results:

$W_2 I_h = W_1 I_{h1} + W_3 I_{h3}$ (7)

in which W_1,W_2 ,and W_3 are the amount of turns of the main winding, the prolonged winding, and the common winding, respectively.

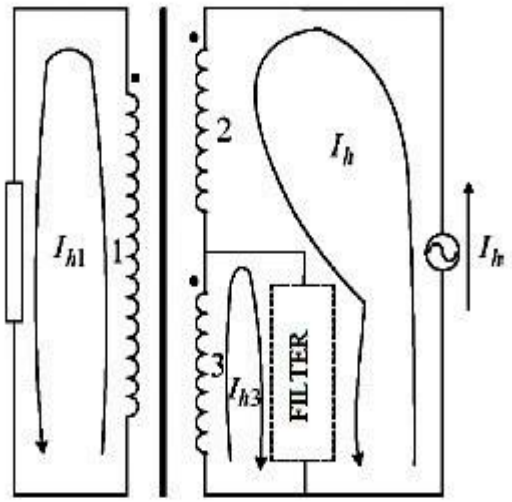


Fig 4. New Converter transformer's single phase model

If the ampere-turns of the secondary extended winding and the not unusual place winding is stored balanced then I_{h1}turns into zero. There isn't anybrought about harmonic contemporarywith inside thenumber one winding [11] . Therefore, the harmonic currents go with the driftmost effectivewith inside the secondary winding of the brand new converter transformer.

To recognize the inductive filtering technique, it now no longerbestdesiresthe total tuning of the filter, howeveradditionallydesires the 0 impedance layout of the secondary not unusual place winding of the brand NCT. It is analyzed with inside thenext single-sectionversionof latest converter transformer as proven in Fig.6.

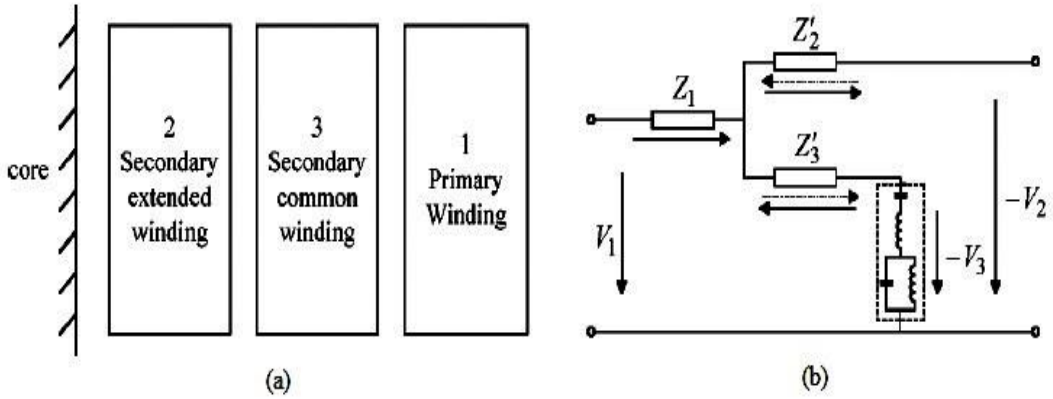


Fig. 5. Single-phase classicalModel of CT.
(a) Wiring plan. (b) Equivalent circuit.

The short-circuit impedancesZ_{12},Z_{13},and Z_{23}. has been gained from short circuit test. Fig. 6.(b) shows the corresponding impedance model of new converter transformer. The impedance value can be expressed as follows:

$$\left.\begin{aligned} Z_1 &= 0.5\,(Z_{12} + Z_{13} - Z'_{23}) \\ Z'_2 &= 0.5\,(Z_{12} + Z'_{23} - Z_{13}) \\ Z'_3 &= 0.5\,(Z_{13} + Z'_{23} - Z_{12}) \end{aligned}\right\} \quad (8)$$

By regulating the winding associationproven in Fig. 6(a), the secondary not unusual place winding impedance of latest converter transformer is completeextra or much lesssame to zero (the resistance may bedisregarded for high-potential converter transformers). So the harmonic present dayin particular flows handiestwith inside thedepartment of the secondary not unusual place winding, and there may be no harmonic present daywith inside thenumber one winding. Equivalent Circuit Model.

Fig. 7. Shows the equal circuit version of the IAF. In this version, the secondary winding of the brand NCT adopts extended winding and the not unusual place winding. There is a connection factor for every segment among the extended winding and not unusual place winding wherein tuned clear out has been connected

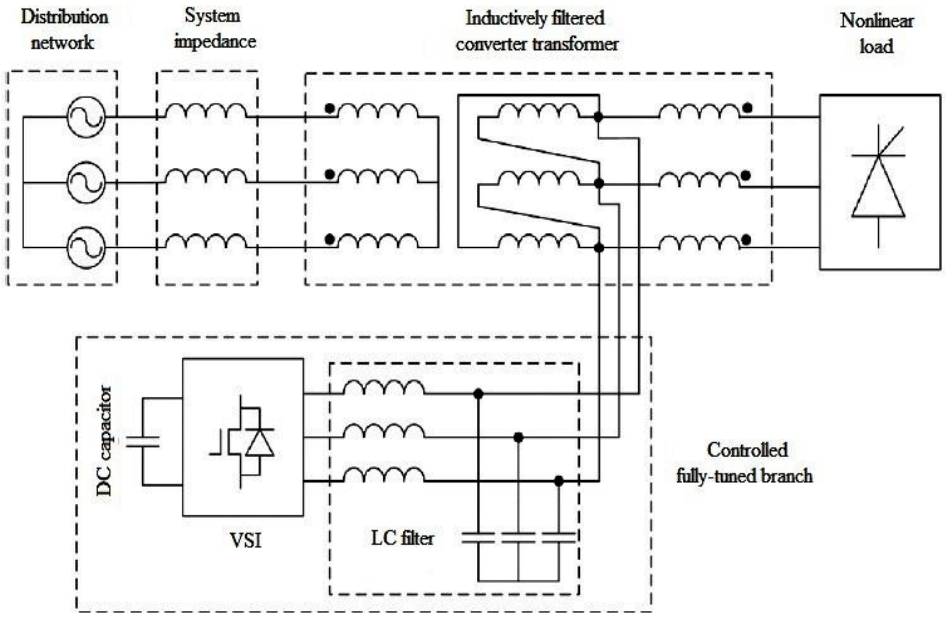
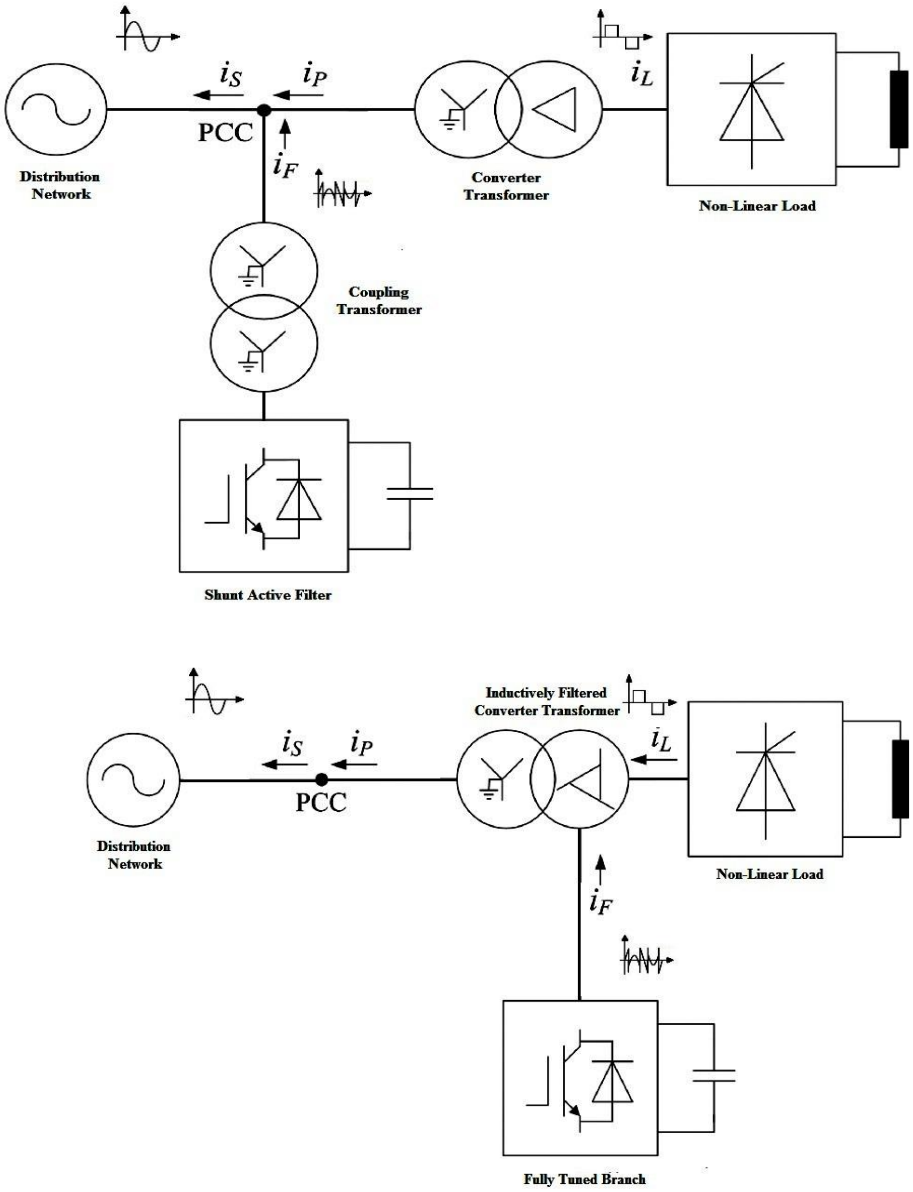


Fig 6.Wiring scheme of IAF

To make an adjusting symphonious capacity this extraordinary optional winding design become made. In this manner, the acceptance of consonant flows at the main twisting of the transformer has been evaded adequately

The geographies of the customary APF and the proposed IAF methods are as analyzed in Fig. 8. The customary APF is normally done on the Point of Common Coupling. The coupling transformer is utilized to interface with the energy machine as demonstrated in Fig. 8(a). Nonlinear masses like rectifier took care of DC engine drives are identified with the dissemination machine through converter transformer. To separate the dc convey machine from the circulation network a converter transformer is utilized. [12]

3. III.System Configuration



(b)

Fig. 7. Contrast of topologies: (a) Old-fashioned APF located at the PCC side, (b) future IAF coordinated with the NCT

From Fig 8(a) it's farunderstandable that the harmonic load contemporary $i_L$movements into the PCC to converter transformer. The CT has to be afflicted bythe harmonic and reactive energyadditives from burdencontemporary i_L. It

ends indelivered losses, growth in temperature, shaking, and noise. Once APF is attachedmatching with the converter bridge, the commutation system of the rectifier load receivestormented by the impedance of the APF. Thus, the PQ issuescannot be averted for the converter transformer in conventional APF method.

The topology of the future IAF technique is proven in Fig. 8(b). In this figure, an inductively filtered CTis attachedamong the non - linear load and the source. Tuned livelyclear outis attachedamong the extended winding and not unusual place winding of the brand new converter transformer. The clear out draws the harmonic additives. Thus, the number one winding is loose from harmonics. In this way, the harmonic additives are suppressed close to the nonlinear load (harmonic source) itself. It method the course of harmonic glide is confined in a small area, which notably reduces the effect of harmonics at thedelivery system.

4. Unified Power Quality Conditioner

UPQC is the blending of assortment (APFse) and shunt (APFsh) energetic energy channels, related once more to-again at the dc angle, sharing a not irregular spot DC capacitor demonstrated in Figure 3. The assortment thing of the UPQC is responsible for moderation of the convey angle aggravations: voltage lists/swells, glimmer, voltage unbalance and sounds. It embeds voltages with the goal that you can keep the weight voltages at a favored level; adjusted and twisting free. The shunt thing is responsible for relieving the cutting edge five star inconveniences coming about because of the customer: negative energy factor, load consonant flows, load unbalance and so forth It infuses flows with inside the air conditioner device to such an extent that the inventory flows develop to be adjusted sinusoids and in segment with the stock voltages. The widespread element of UPQC especially depends upon at the assortment and shunt APF regulator. A basic helpful square outline of an UPQC regulator is demonstrated in Figure 4. Here, the shunt APF infuses the remunerating receptive and consonant current the use of hysteresis present day regulator and keeping in mind that the assortment APF utilizes PWM voltage regulator to limit the voltage unsettling influences [8].

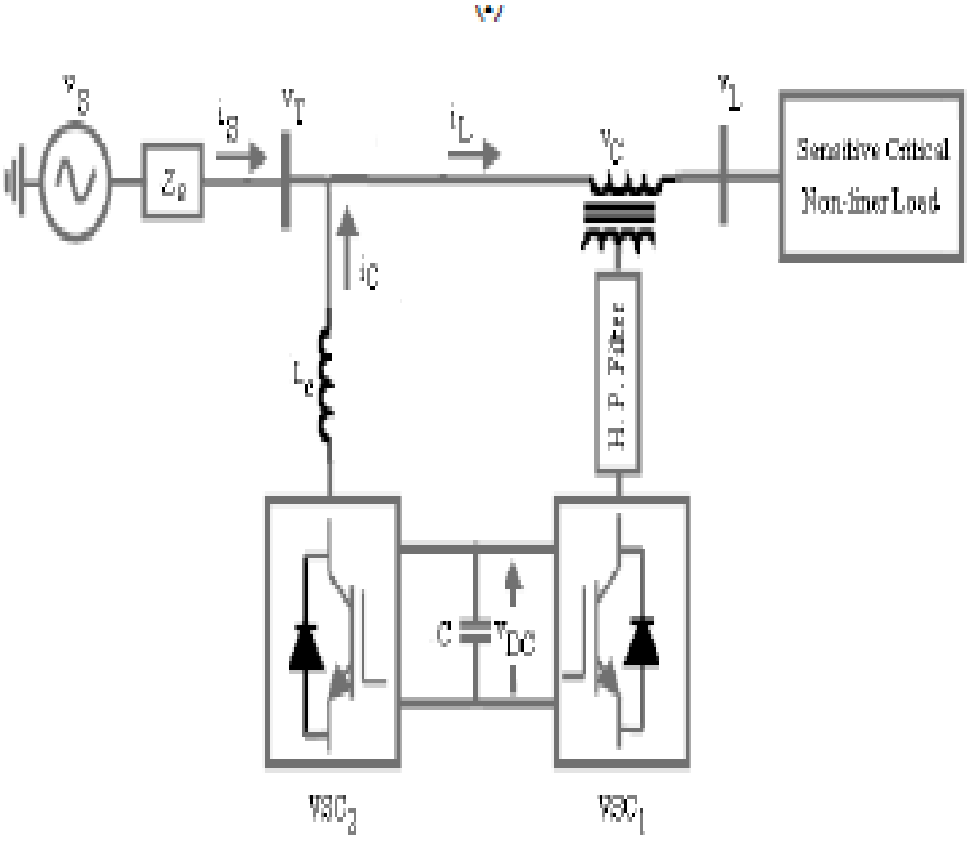


Fig 8 New Converter Transformer Integrated with UPQC

5. Filtering Performance

Fig. 9 and Fig. 10 shows the PSCAD/EMTDC consequences of the customary APF and the IAF strategy, individually. In Fig 9 (a). And10.(b). it is seen that heap current has symphonious parts, which is dictated by the kind of nonlinear burden.

It can likewise be seen from Figs. 9 (c) and 10 (c) that customary APF and IAF techniques can forestalls the symphonious flows entering the source side, in this way improving the force nature of the appropriation organization.

In Fig. 9(b), it is obvious that the consonant current courses through the converter transformer. From Fig.10(b) is certain that the proposed IAF technique has forestalled the symphonious current entering the transformer and it smothers the consonant segment at the optional winding itself

Fig.9.PSCAD/EMTDC results of the CT with APF.(a) Current at the load side. (b) Current in the PCC Point .(c) Current at the source side

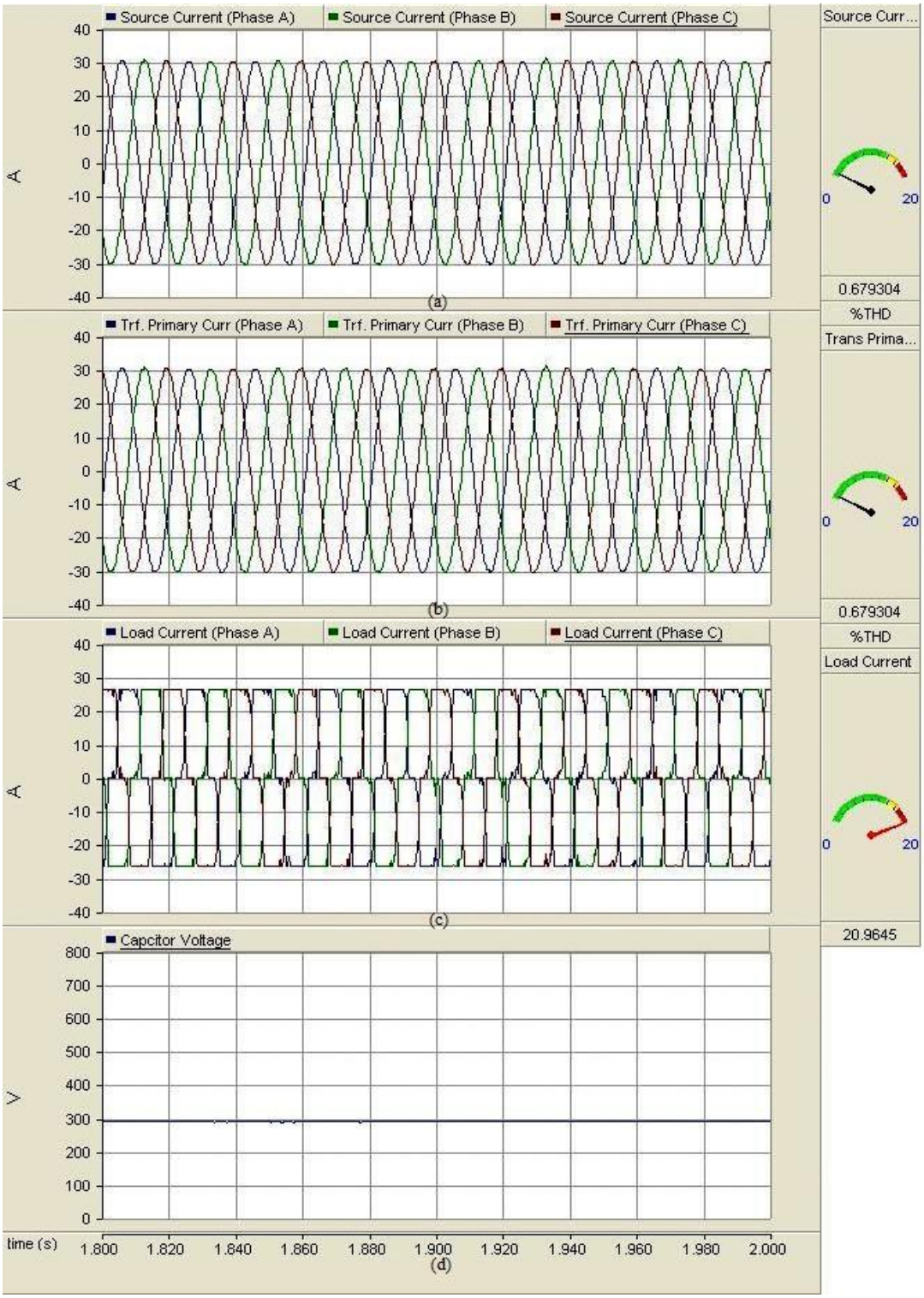


Fig. 10. PSCAD/EMTDC results of NCT with LS - UPQC (a) Current at the load side. (b) Current in the PCC Side.(c) Current at the Source side

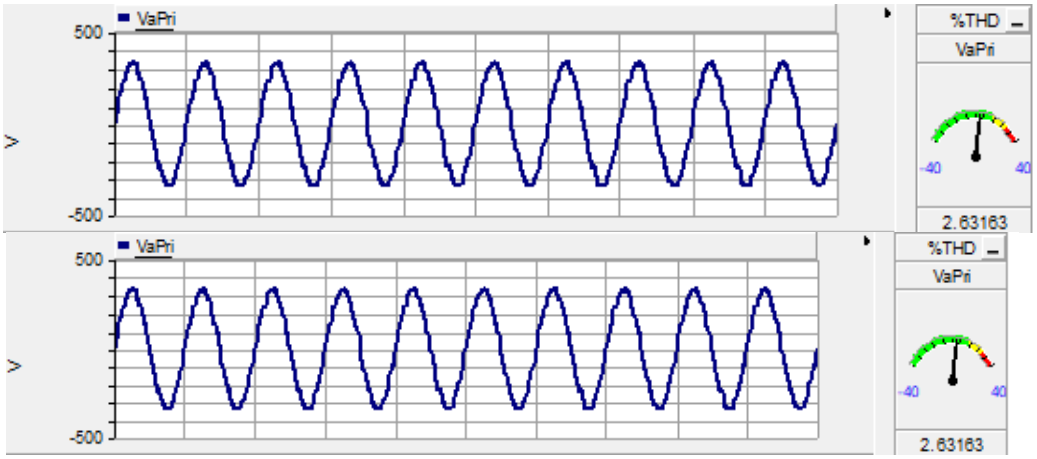
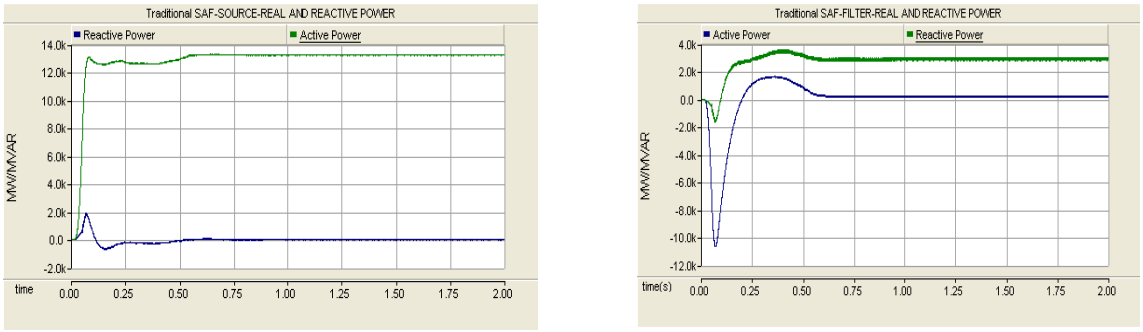


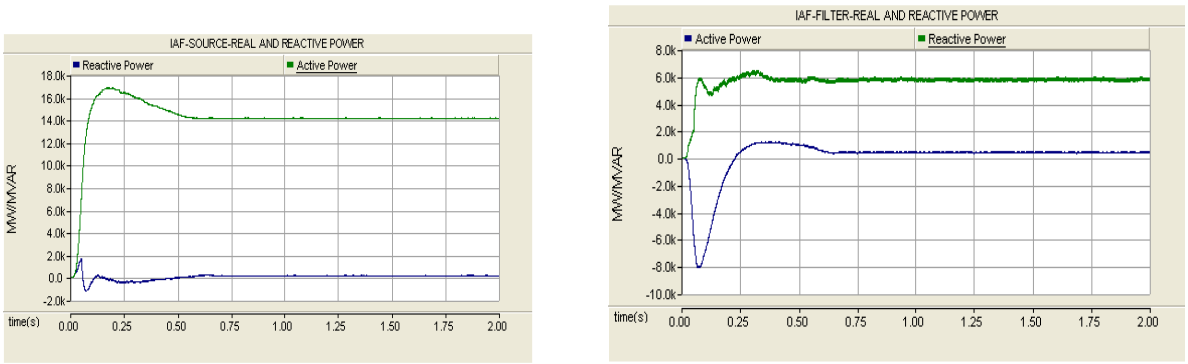
Fig 11. Voltage compensation in at thesides of LS UPQC

Real and reactive power measurement is shown in fig.11 and fig.12.It is observed from fig11 (a) and 12(a) that the reactive power consumption from the source is zero MVAR. The reactive power required for the load is generated by the active filter as shown fig11 (b) and fig 12(b).



(a) (b)

Fig 12. Real and Reactive power flow NCT with SAF(a) Source Side (b) Filter Side



(a) (b)

Fig 13Real and Reactive power flow NCT with LS UPQC (a) Source Side (b) Filter Side

6. Conclusion

In this paper consequences of new Converter Transformer with shunt dynamic channel and a New Converter Transformer with LS - UPQC is analyzed. It is apparent from the reproduction consequence of PSCAD/EMTDC that the New Converter Transformer with UPQC technique viably lessens the consonant part of both voltage and current close at the symphonious source and keeps the converter transformer from the music. Thusly, the transformer and the appropriation network is liberated from the impacts of music and nature of intensity can be improved.

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