
Simulation of APLC with a PI controller for a three-phase, four-wire system with four switching leg

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Abstract: - Recently active power filters are in trend to overcome these issues. So in this work an APLC is simulated with a traditional (PI controller) for a three-phase, four-wire system with four switching legs. The PI controller performs well in the steady state, but not so well when there is non-linearity, parameter variation, or load shift (transient condition). It necessitates a precise mathematical relationship and is thus susceptible to parameter fluctuation. Many controllers, such as Fuzzy, are available for performance optimization, but they are not satisfactory. The major goal is to improve the controller's transient response. Parallel architecture allows the controller to compute quicker and does not require specific input output relationships, as ANN has become a more advanced tool in recent years due to features such as self-learning ability. As a result, an ANN-based controller is used. For the creation of the reference current signal, a feed forward neural network trained using the LM method is used.

Keywords: APLC, PI Controller, Power quality

1. INTRODUCTION

Active power filters (APFs) are increasingly more seen as a viable opportunity to classic passive filters and static VAR compensators for decreasing harmonics and reactive energy necessities of non-linear loads. These gadgets are known as energetic filters, energetic energy line conditioners (APLCs), immediate power compensators (IRPCs), and lively electricity pleasant conditioners (APQCs). These are typically voltage or contemporary source PWM converters, with switches controlled to attract/supply a compensating current from/to software so one can cancel current harmonics on the AC facet by using producing in phase competition of mains voltage, based on most effective harmonic reimbursement or harmonic and reactive strength repayment.

Active filters also are used to decrease voltage harmonics, load balancing, terminal voltage law, voltage flicker suppression, and other applications. We were able to achieve a wide variety of objectives singly or in combination, depending on the demands, control mechanism, and configuration that we employed. Due to the lack of an energy storage element, the filter size and cost are reduced, resulting in minimum losses and high efficiency. Due to the availability of high power and high switching frequency IGBTs and MOSFETs, it may be employed in medium and high power applications. Because of all of these advantages, active filters, also known as APLC, have gotten a lot of interest as a means to alleviate power quality concerns.

2. TOPOLOGIES

Mid-point capacitor and four switching leg topologies are the two topologies for three phase four wire systems. The downside of the mid-point capacitor design is that it necessitates a dc link capacitor with double the value, and the full neutral current passes through it, necessitating bigger capacitor ratings. As a result, it was mostly employed for low-level evaluations. The topology with the four switching legs is although it needs two more IGBTs with its driver circuit, it is chosen because of its superior performance over other topologies.

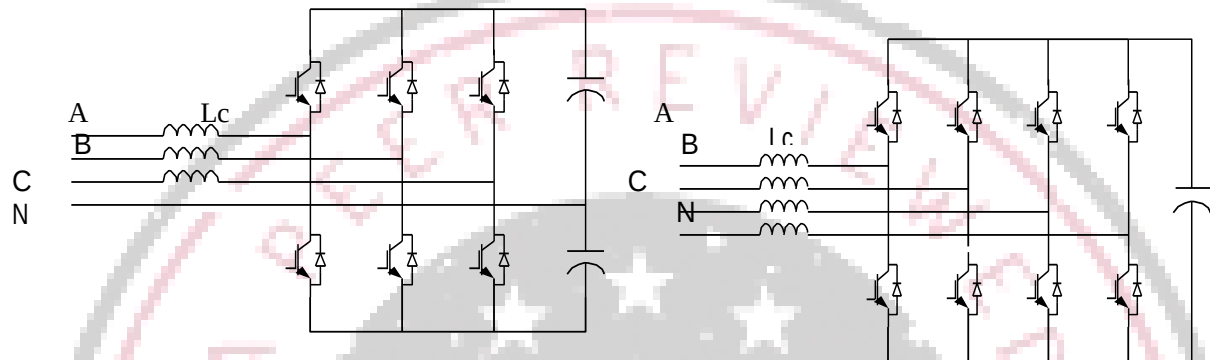


Fig.2.1 Mid-point capacitor and four switching leg topology

2.1 ESTIMATION OF REFERENCE SIGNAL

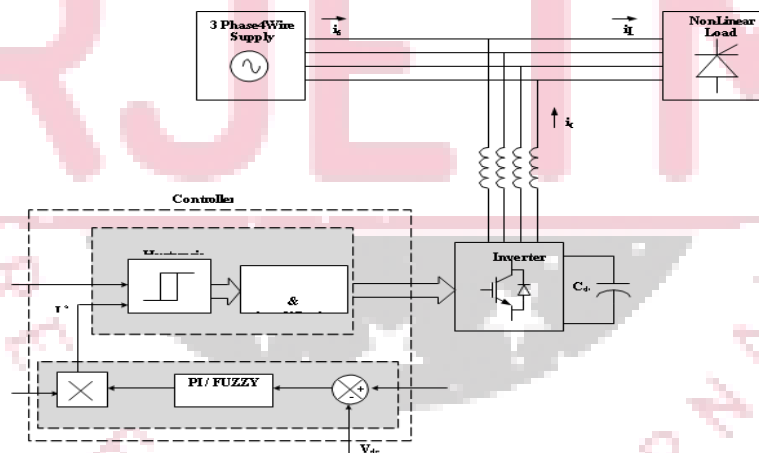


Fig.2.2 Block diagram of Active Power Line Conditioner

An APLC block diagram for a three-phase, four-wire system is shown in Figure 2.3. The three phase supply is distributed to three single phase nonlinear loads. A VSI with four switching legs is used to correct for harmonic currents. The control system for the four switching leg design is split into two stages: one for establishing a reference current signal and the other for generating pulses to the inverter. The source voltage is measured and utilised to build a unit template, which is then multiplied by the output of the PI controller to give reference current to compensate for harmonics in the source current. The difference between the reference dc voltage and the dc link voltage is sent into the PI controller as an input. The created reference current is compared to measured currents in the second stage, and VSI pulses are generated using a hysteresis control

2.2 SIMULATION MODEL.

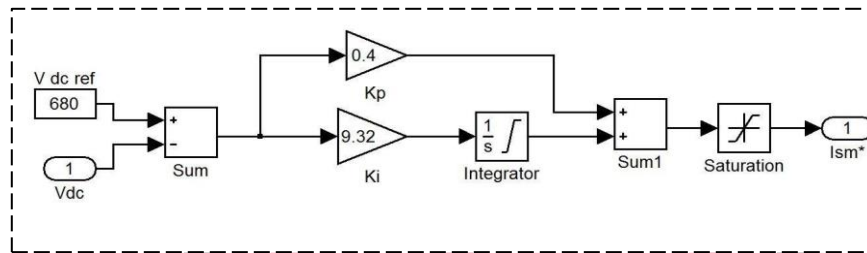


Fig.2.4. Simulation model of conventional controller and blocks of PI controller

2.2.1 TRANSIENT CONDITION RESULTS OF BALANCED THREE SINGLE PHASE NON-LINEAR LOAD

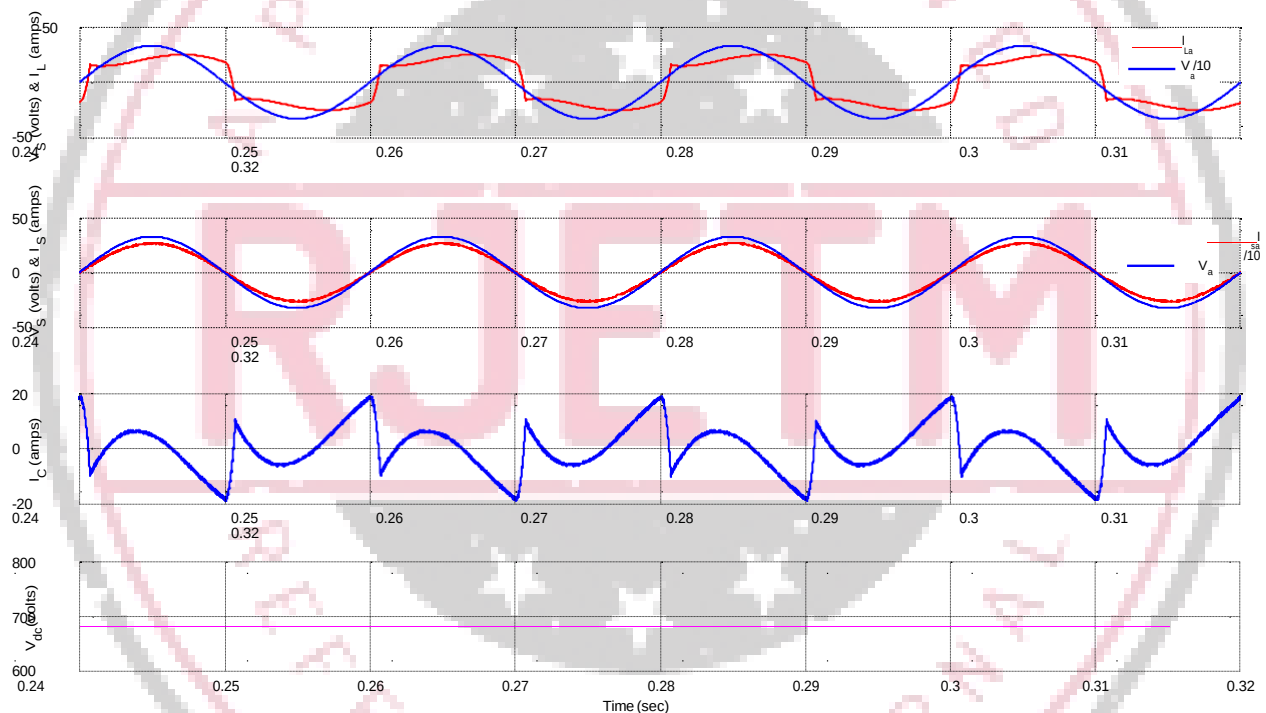


Fig.2.8. Switch-in response of APLC with PI controller of (Phase A)

3. DESIGN OF ANN BASED CONTROLLER

The conventional APLC with PI controller as shown in figure 2.3, is replaced here with the ANN based controller. Firstly, the data or samples (input and target) are collected from the conventional system which should be in a row matrix. Then, the data is used for training the ANN with learning algorithm. The training continues until the goal is reached; i.e., after selecting the type of architecture of ANN and type of learning algorithm, the training continues until the error is in acceptable limits. After successful completion of training weights and bias are generated for the Selected type of ANN. The block diagram of feed forward ANN for replacing PI controller is shown in the figure 3.1

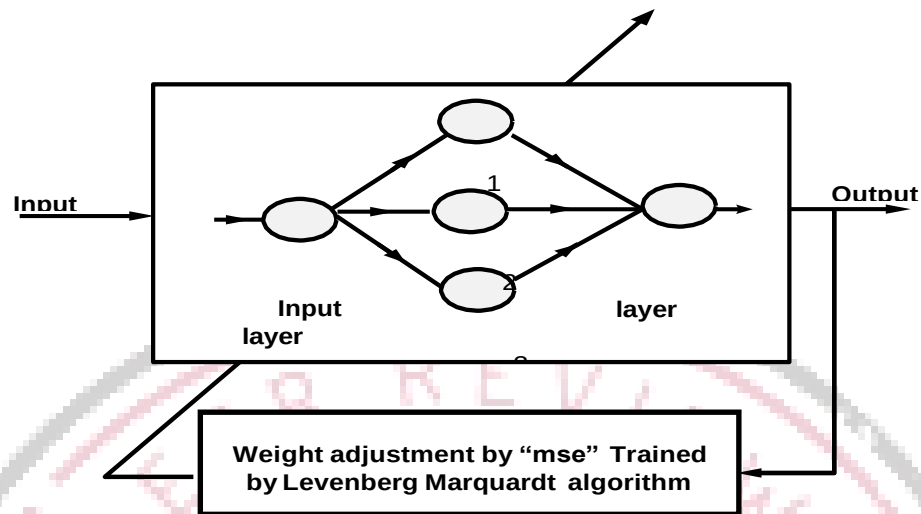


Fig. 3.1 Feedforward ANN for replacement of PI controller

3.1 SIMULATION OF ANN BASED CONTROLLER FOR APLC

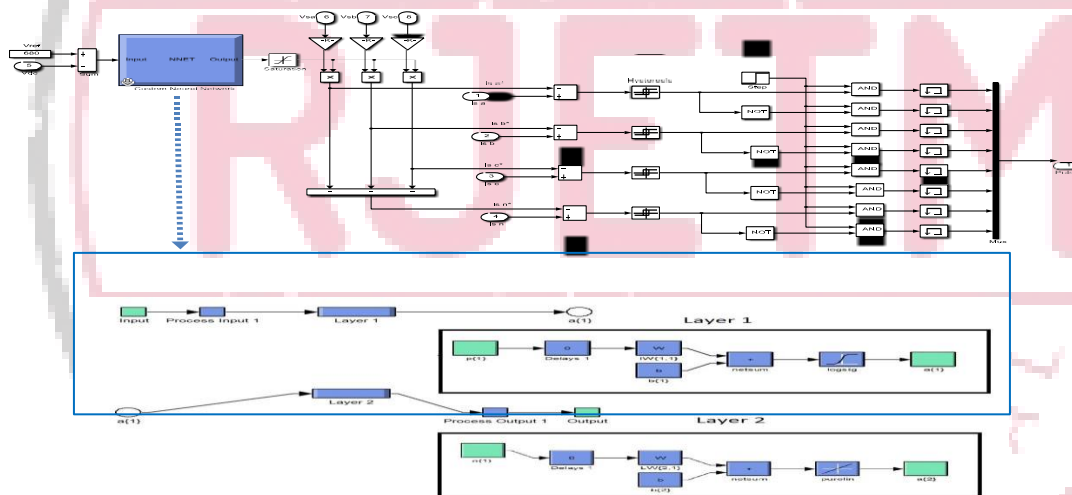


Fig.3.2 Simulation model of ANN based controller with its inner blocks

3.1.1 STEADY STATE RESULTS OF BALANCED THREE SINGLE PHASE NON-LINEAR LOAD

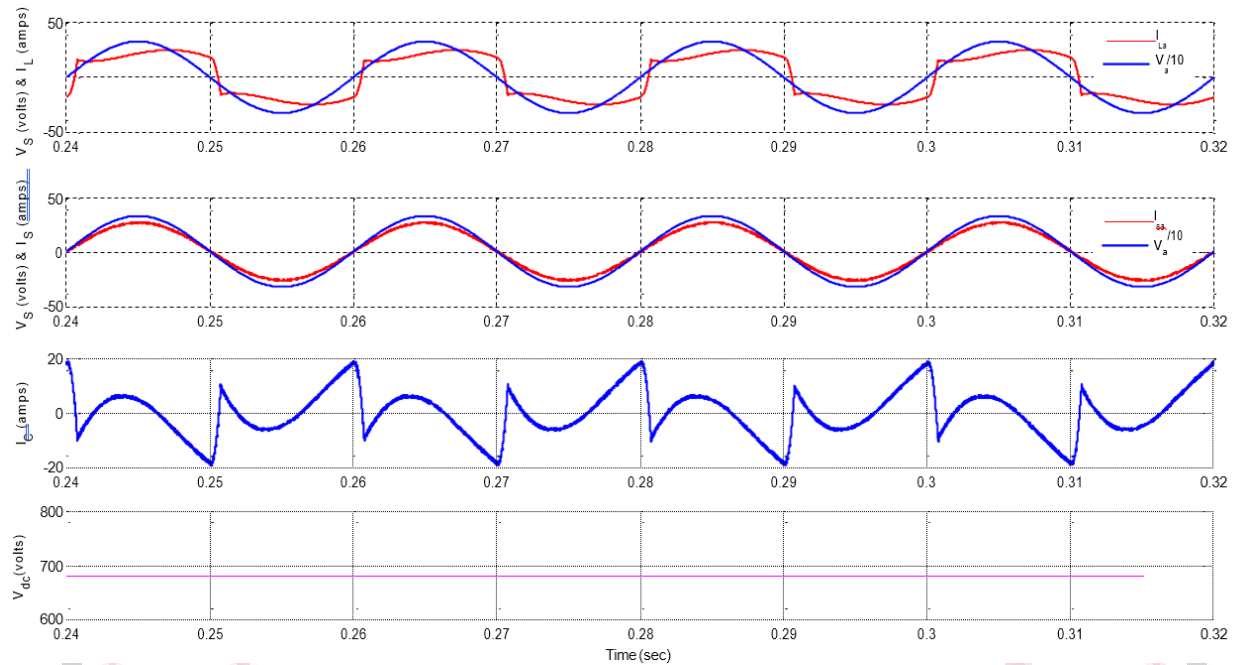


Fig.3.3 Simulation results after compensation in steady state with PI controller (Phase A)

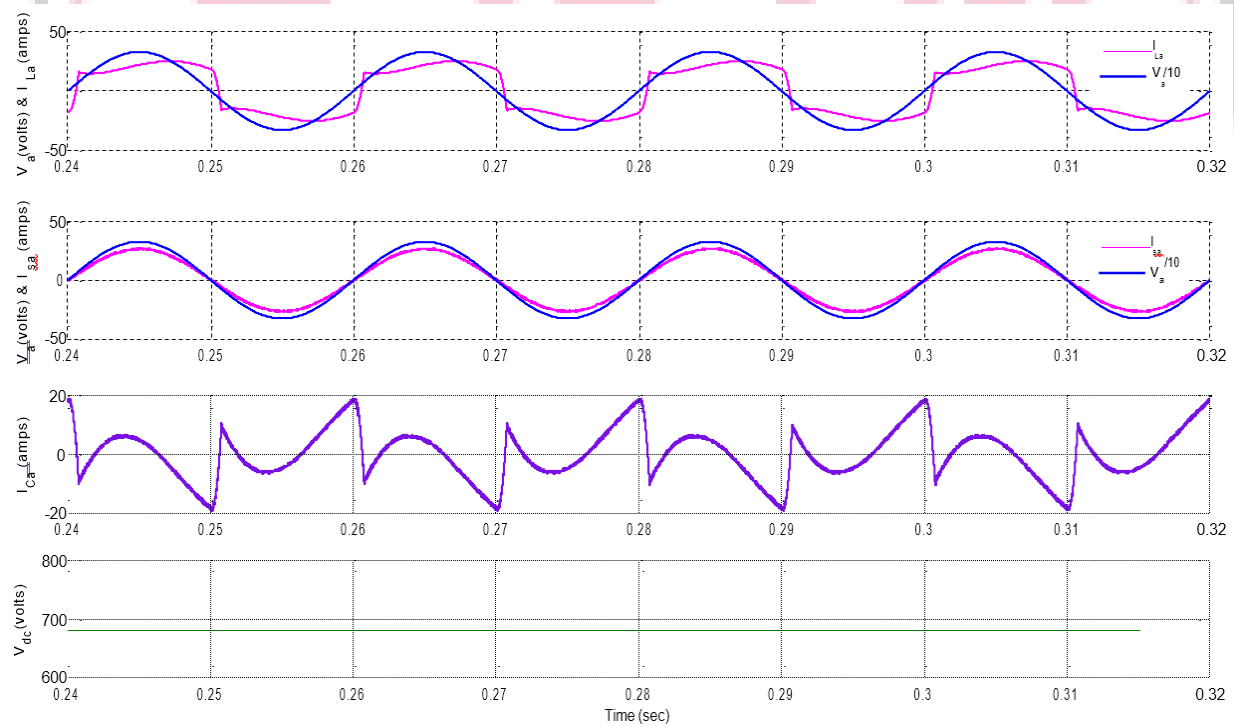


Fig.3.4 Simulation results after compensation in steady state with ANN controller (PhaseA)

4. RESULTS

4.1 SIMULATION MODEL

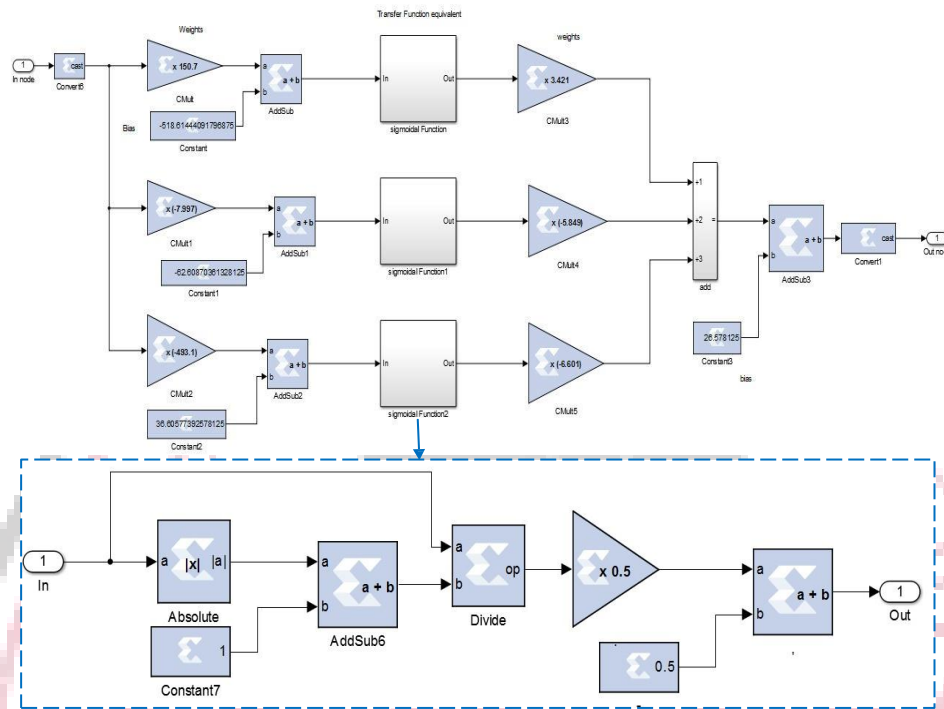


Fig.4.1 FPGA Implementation of ANN based controller for APLC with its equivalent function

A. STEADY STATE RESULTS OF BALANCED THREE SINGLE PHASE NON-LINEAR LOAD:

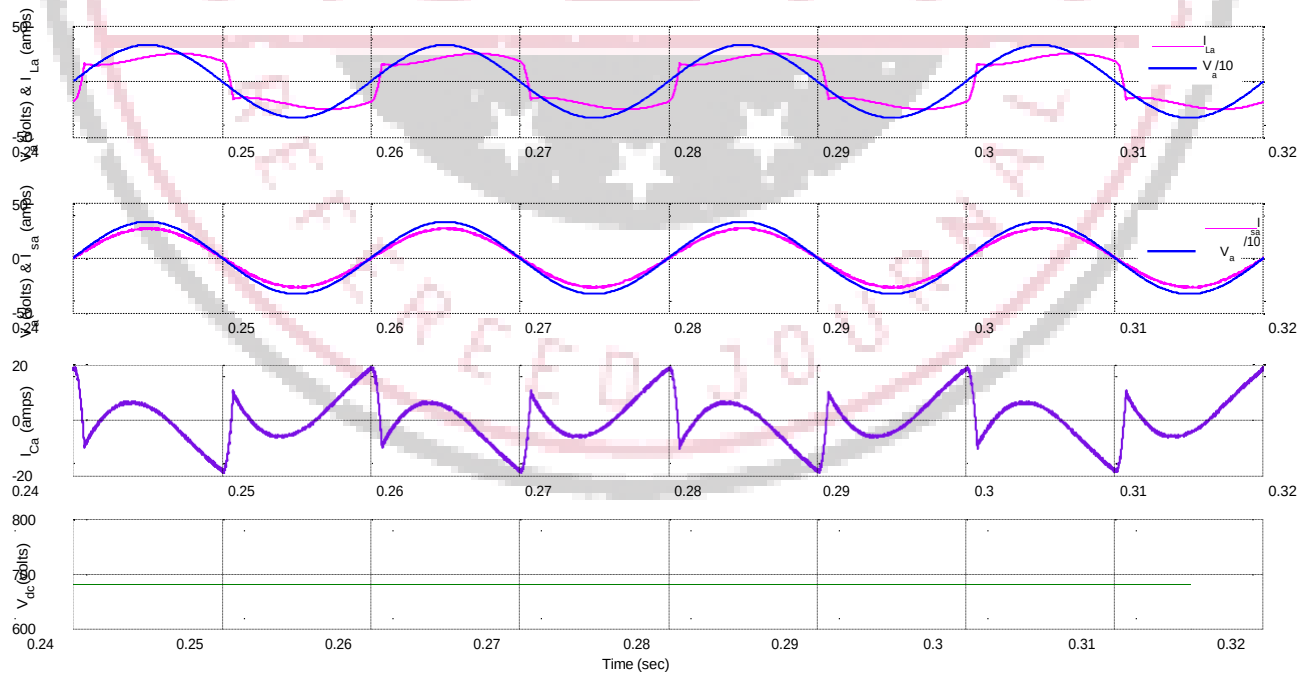


Fig.4.2. Simulation results after compensation in steady state with ANN controller (Phase A)

B. TRANSIENT CONDITION (LOAD CHANGE) RESULTS OF BALANCED THREE SINGLE PHASE NON-LINEAR LOAD:

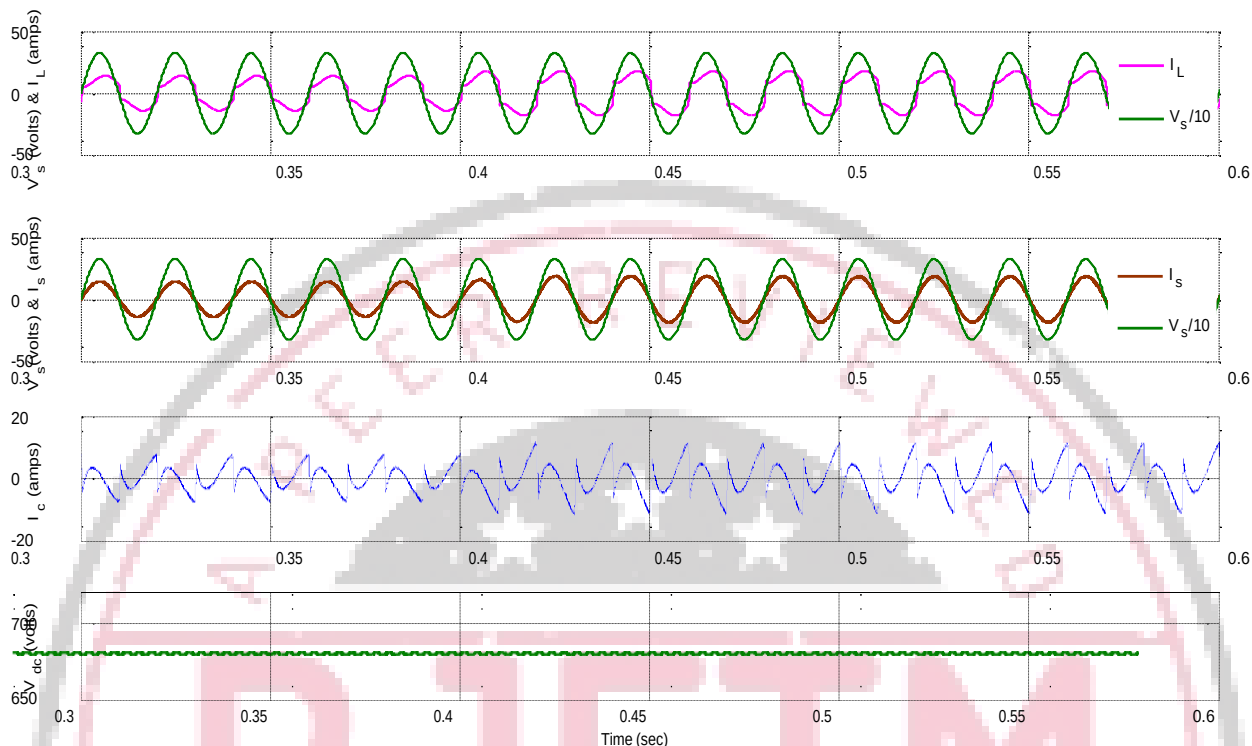


Fig.4.3 Response of change in load (15% increases) with ANN controller (Phase A)

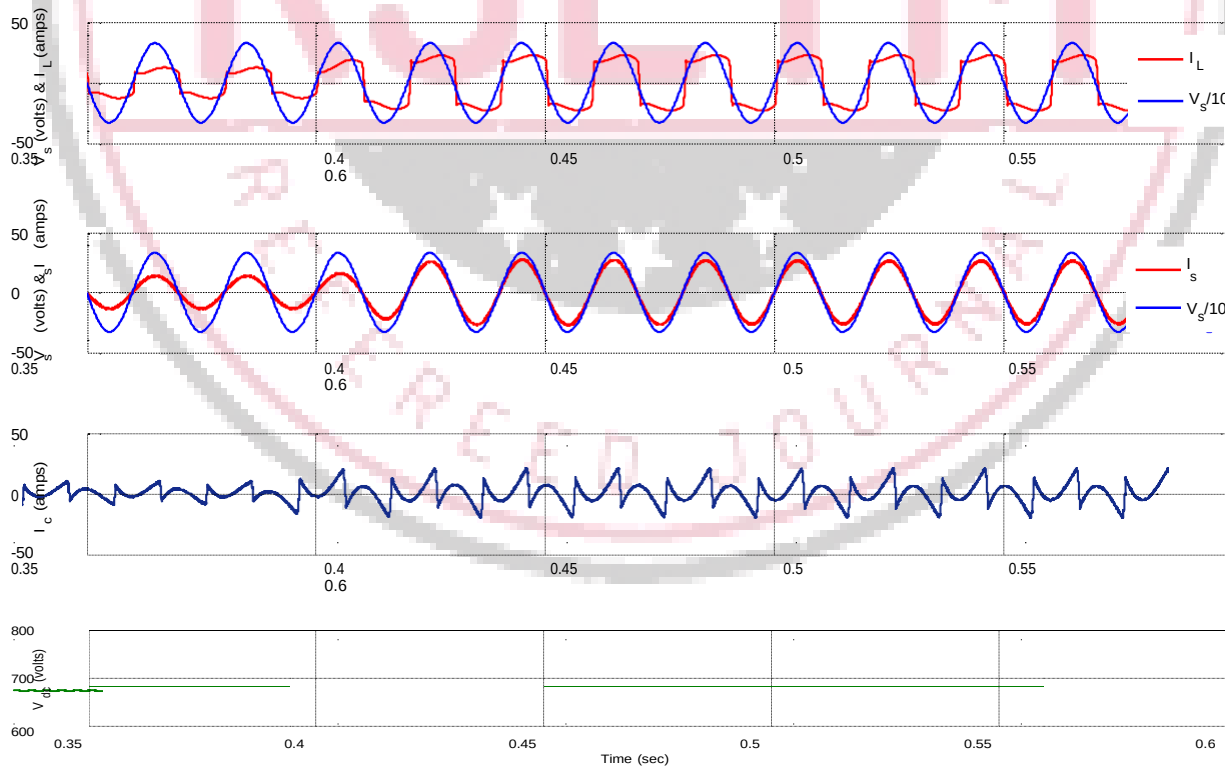


Fig.4.4 Response of change in load (25% increases) with ANN controller (Phase A)

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