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A PFC CUK CONVERTER FED BLDC MOTOR DRIVE USING ARTIFICIAL NEURAL NETWORK

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Abstract - In this paper a Power Factor Correction Cuk converter fed Brushless DC Motor Drive using a Artificial Neural Network is used. The Speed of the Brushless dc motor is controlled by varying the output of the DC capacitor. Here we are evaluating the three modes of operation in discontinuous mode and choosing the best method to achieve maximum Power Factor and to minimize the Total Harmonic Distortion. We are comparing the conventional PWM scheme to the proposed Artificial neural network. Here simulation results reveal that the ANN controllers are very effective and efficient compared to the PI and Fuzzy controllers, because the steady state error in case of ANN control is less and the stabilization if the system is better in it. Also in the ANN methodology the time taken for computation is less since there is no mathematical model.The performance of the proposed system is simulated in a MATLAB/Simulink environment and a hardware prototype of the proposed drive is developed to validate its performance.

Key Words: *Brushless dc motor, Discontinuos input inductor mode , Discontinuous output inductor mode, Discontinuous intermediate capacitor mode ,Cuk converter,Power Factor Correction,Total Harmonic Distortion, Artificial Neural Network,Pulse width modulation*

1. Introuction

Brushless Dc Motor is recommended for many low cost applications such as household application, industrial, radio controlled cars, positioning and aeromodelling, Heating and ventilation etc. ,because of its certain characteristics including high efficiency, high torque to weight ratio, more torque per watt , increased reliability, reduced noise, longer life, elimination of ionizing sparks from the commutator, and overall reduction of electromagnetic interference(EMI) etc. With no windings on the rotor, they are not subjected to any centrifugal forces, and because the windings are supported by the housing, they can be cooled by conduction, requiring no airflow inside the motor for cooling purposes. The motor's internals can be entirely enclosed and protected from dust, dirt or any other foreign obstacles. There are some draw backs in using conventional Power Factor Correction Methods, By using a Boost converter in Discontinuous Current Mode leads to a high ripple output current. The Buck converter input voltage does not follow the output voltage in DCM mode and the output voltage is reduced to half which reduces the efficiency.In our proposed system front-end Cuk converter is used in both continuous and discontinuous mode because of its certain advantages like easy implementation of the transformer isolation ,protection against high inrush current ,low current ripple and also low electromagnetic interferences. In this paper we are using a Cuk converter for PFC correction to the maximum value and to attain a low value of THD using Artificial neural network.

1.1 PFC CUK CONVERTER FED BLDC MOTOR USING ARTIFICIAL NEURAL NETWORK

In this proposed scheme using Artificial Neural Network (ANN),The AC source followed by a diode bridge rectifier to convert AC source to DC is boosted or bucked using the switching pulse given to the MOSFET switch of a cuk converter is fed to a inverter fed Brushless DC motor. Here the power factor is made approximately to the unity by using the cuk

converter. Here the speed is not sensed ,only the cuk converter output voltage is sensed and compared with the reference speed 2000rpm the output is given to a Artificial neural network which consist of two main functions Transig and Purelin. The error signal is given to the first layer Transig which removes the complex, imaginary minimized values and only allows the real values p. This p is given after a delay is given to various constant weights their product is given to a mux is compared with the biased value and produce the output a(1).This function a(1) is given to the next neural layer called Purelin with the same process as same as Transig layer.The only difference is that in Transig layer the weighted values are compared with many biased values.but in the case of purelin only 1 bias value is used for the comparison.From the purelin only the real values are permitted and removes all constants,imaginary,complex values etc.This output y(1) is compared with the feed back signal and the error signal is undergone a comparison with the repeating sequence to produce the gating signal for triggering the mosfet. The ANN controllers are very effective and efficient compared to the PI and Fuzzy controllers, because the steady state error in case of ANN control is less and the stabilization if the system is better in it. Also in the ANN methodology the time taken for computation is less since there is no mathematical model

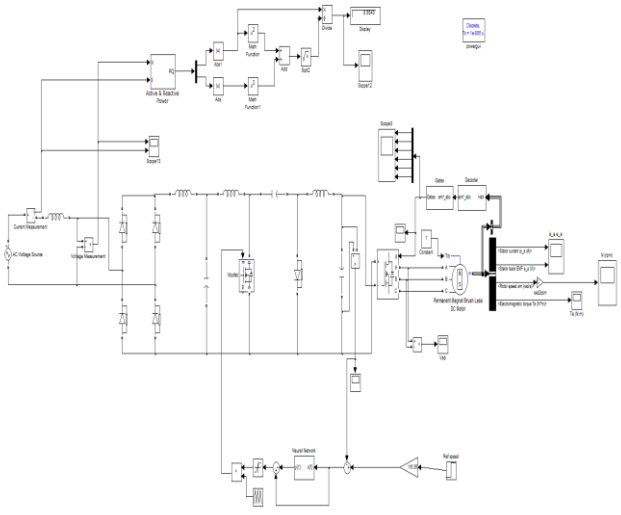


Fig.1.Proposed scheme using Artificial Neural Network

1.2 SIMULATION AND RESULTS

The simulation is carried out in the environment of MATLAB/SIMULINK with a switching frequency Fs=20Khz.Here an AC source of 230V is converted to DC by using a Diode bridge rectifier.The power factor is corrected by using a Cuk converter and fed to a Brushless DC motor. Here we are using Discontinuous input inductor mode (DICM Li) using the following parameters Input inductor L_i = 100 μH, output inductor L_o = 4.3 mH, intermediate capacitor C_1 = 0.66 μF, and dc-link capacitor C_d = 2200 Mf

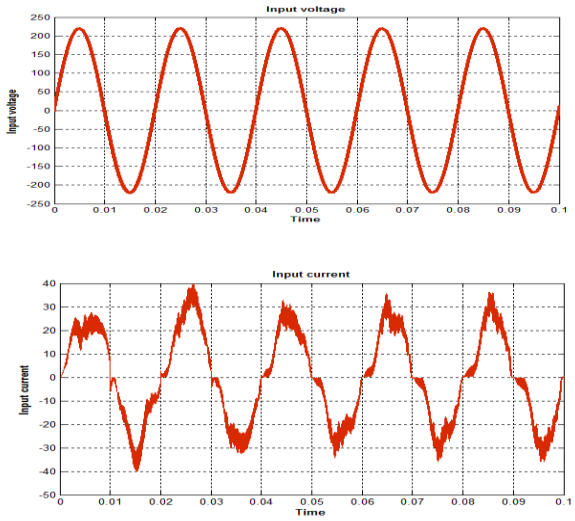
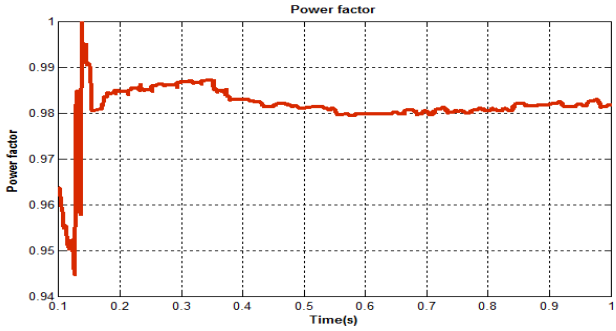


Fig2(a) Input voltage b) Input current

Here we can see that the input current follows the same shape as that of input voltage .Since we are using here DICM(Li) mode there is a discontinuous nature in the input current.We are giving an input of 230V ac and the input current obtained is nearly 20A.



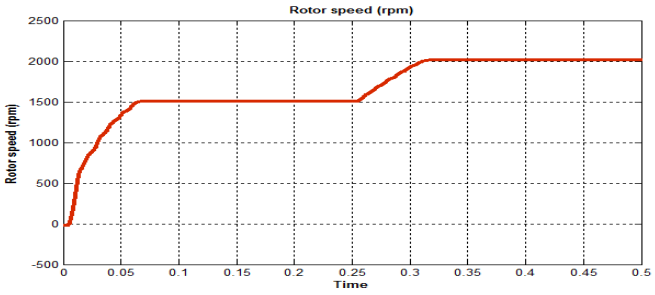


Fig3c)power factor d)rotor speed

Here the power factor obtained is nearly .9612 which is equal to the unity and that is our main aim and speed obtained is 2050rpm

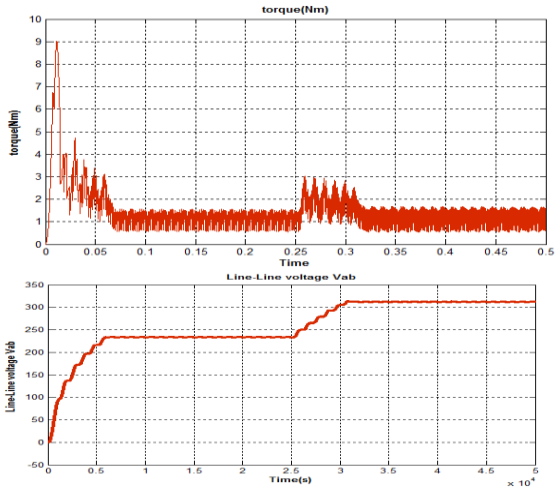


Fig3e)Torque f)Output voltage

For an input voltage of 220V we are getting an output voltage of 310V.The electromagnetic torque that is obtained is of 2Nm

2. COMPARITATIVE STUDY

A comparison is made between ANN and PI control technique and the result is as follows

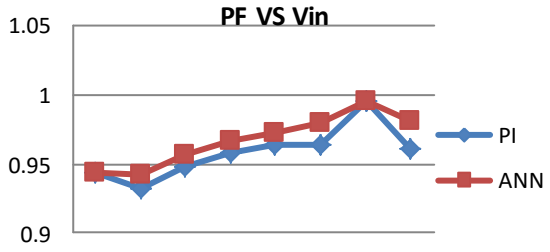


Fig4 PV Vs Vin

From this graph its understood that on comparison ANN is better in PFC correction when compare to PI control technique

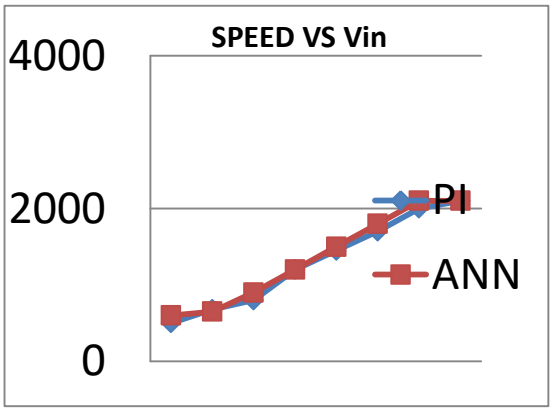


Fig5 Speed Vs Vin

From this graph its understood that on comparison ANN is better in speed control is better when compare to PI control technique

3. CONCLUSIONS

A Power Factor Corrected Cuk converter fed BLDC motor using Artificial neural network is simulated in the environment of MATLAB. The three modes of Discontinuos DICM(Li),DICM(Lo),DCVM(Vco) is simulated at the given switching frequency 20Khz.The diode bridge followed by a Cuk converter is used here for maximum Power Factor Correction. . Here simulation results reveal that the ANN controllers are very effective and efficient compared to the PI and Fuzzy controllers, because the steady state error in case of ANN control is less and the stabilization if the system is better in it. Also in the ANN methodology the time taken for computation is less since there is no mathematical model. The main advantage of using Artificial neural network is that in conventional PI only one value that is feed back is selected and comparing and producing the gating pulse but in our proposed scheme a set of values is compared and we are choosing the best out of them.

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