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Improvement in Torque Production at Low RPMs in Electric Vehicles using Power Electronic Transformer

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ABSTRACT: Torque at low or zero RPMs is one of the most important features of an electric vehicle, higher torque at low RPMs implies better performance on difficult terrains. Electric vehicles struggle with low torque problem at zero or low RPMs especially induction motor driven vehicles. This paper presents an idea to improve torque production at low rpms in electric vehicles by using a power electronic transformer. The main advantage of a power electronic transformer over a conventional transformer is its small size, it can fit inside an electric vehicle and can help it improve various performance parameters.

KEYWORDS: Torque, Low RPMs, Electric vehicle, Power electronic transformer.

I. INTRODUCTION

A vehicle's climbing capabilities are directly linked with torque at zero or low RPMs and its performance on difficult terrains is also primarily dependent on the torque at low RPMs. Electric vehicles struggle with this torque problem, especially induction motor driven vehicles. When it comes to above-mentioned concerns DC motor driven vehicles outperform their induction motor driven counterparts. One possible solution to this problem can be power electronic transformers. As mentioned in [1], power electronic transformer can easily fit inside an electric vehicle and help it improve various performance parameters.

In power electronic transformers, the frequency is increased so significantly that size is reduced by a considerable margin. There are many possible ways to achieve this objective, we are using the configuration given in [2]. Some modifications have been made in the circuit given in [1]. In induction motors, torque is directly proportional to the square of the supply voltage so a transformer can be used here and presence of many energy storage devices reduces its effect on the mileage of the vehicle.

II. THE PROPOSED CIRCUIT

The configuration given in [2] is used here, in [1] some modification has been made. Some further modifications have been made in the configuration. This configuration has three stages namely, input stage, isolation stage, and output stage.

In input stage, Battery is connected to two step-up choppers in cascade to a DC-link capacitor and there is a third quadrant chopper connected in parallel to the first chopper. Only one of these chopper works at a time, it is done through proper switching. In isolation stage, the output of the input stage is connected to an inverter where its frequency is increased to the required frequency, 1000 Hz in this case and it is connected to the transformer, secondary of the transformer is connected to a full wave rectifier. In output stage, the rectifier output acts as an input to a three-phase inverter through a DC-link capacitor which is supplied to an induction motor load. If required, multiple motors can also be used.

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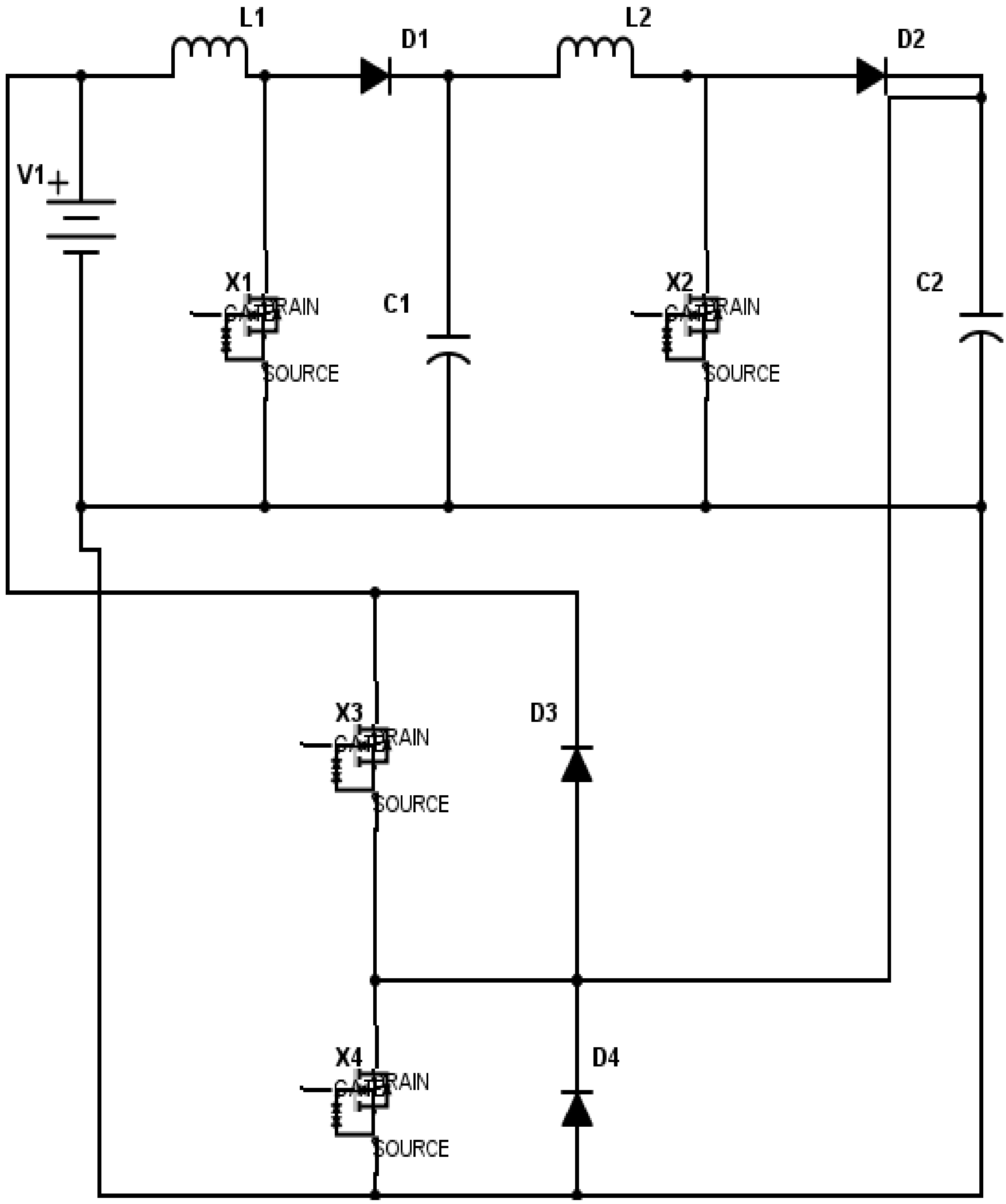

Fig 1 The input stage

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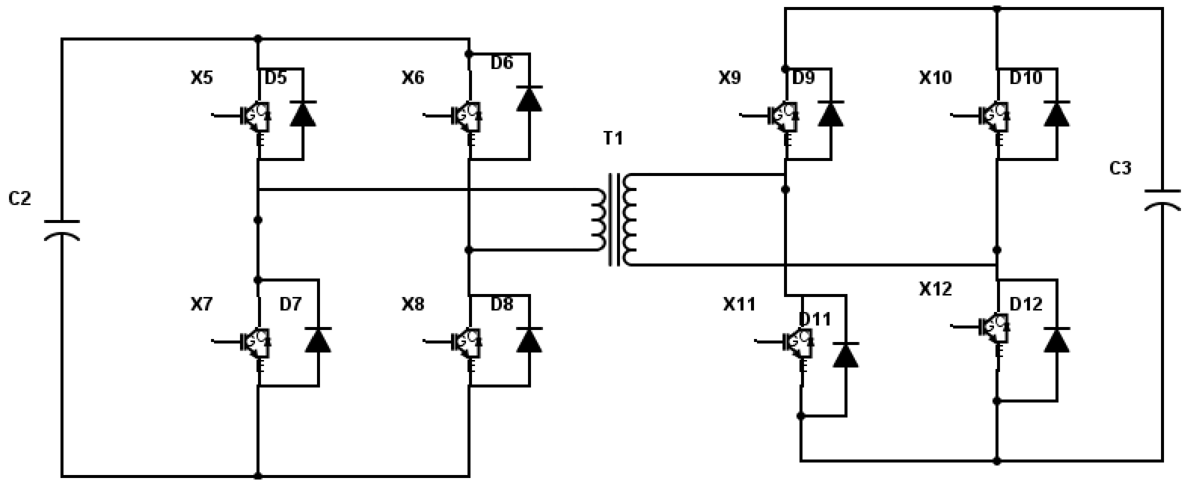

Fig 2 The isolation stage

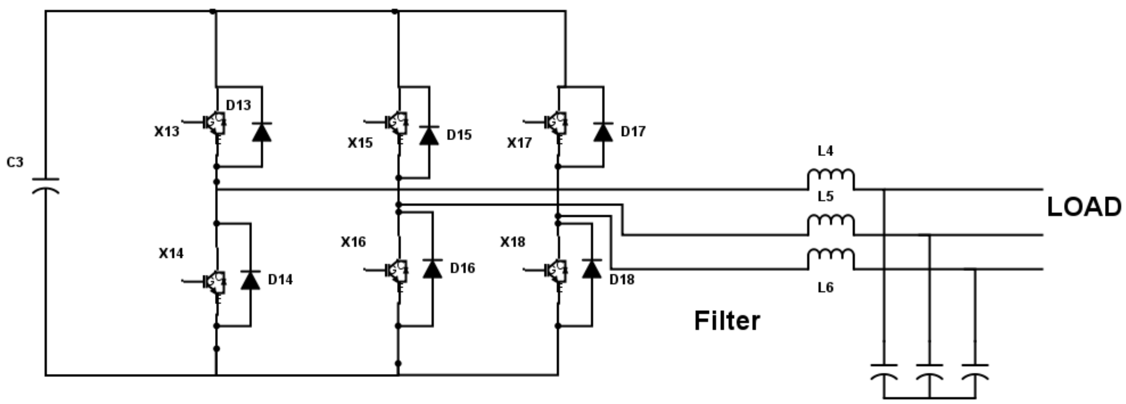

Fig 3 The output stage

III. SIMULATIONS

Exact replica of the above-mentioned circuit is simulated in MATLAB-Simulink software. In the first simulation, single induction motor was used as a load. In the second simulation, two motors were used.

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Table 1 Various parameters and their values

Parameters	Values
V1	375 volts
The duty cycle of the first chopper X1	0.7
The duty cycle of the chopper X2	0.6
The duty cycle of the chopper X3	0.2
The duty cycle of the second chopper X4	0.8
Inductor L1	0.136 H
Inductor L2	0.136 H
Capacitor C1 = Capacitor C2	10 micro Farad
Rated frequency of the transformer	1000 Hz
Turn ratio of the transformer	1:370
Power rating of the transformer	5 MVA
Capacitor C3	1 mF
Filter inductors	0.056 H
Filter Capacitors	47 micro Farad
Induction motor power rating	450 HP
Induction motor Number of poles	2

IV. RESULT AND DISCUSSIONS

In both simulations, torque was measured at close to zero RPM. In the first simulation with one motor as a load maximum starting torque was 432 N-m. In the second simulation, maximum starting torque was 613 N-m.

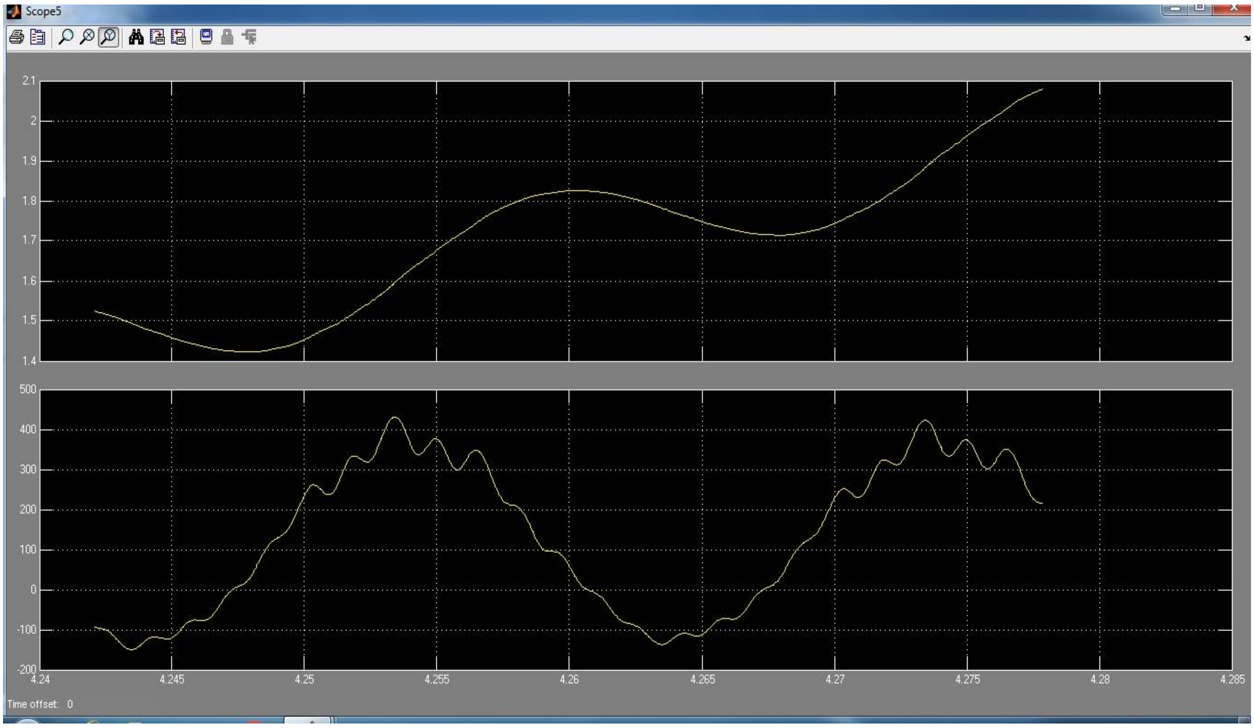

Fig 4 Speed in rpm and torque in N-m both are measured against time in seconds. First curve Speed V/S time. Second curve Torque V/S time

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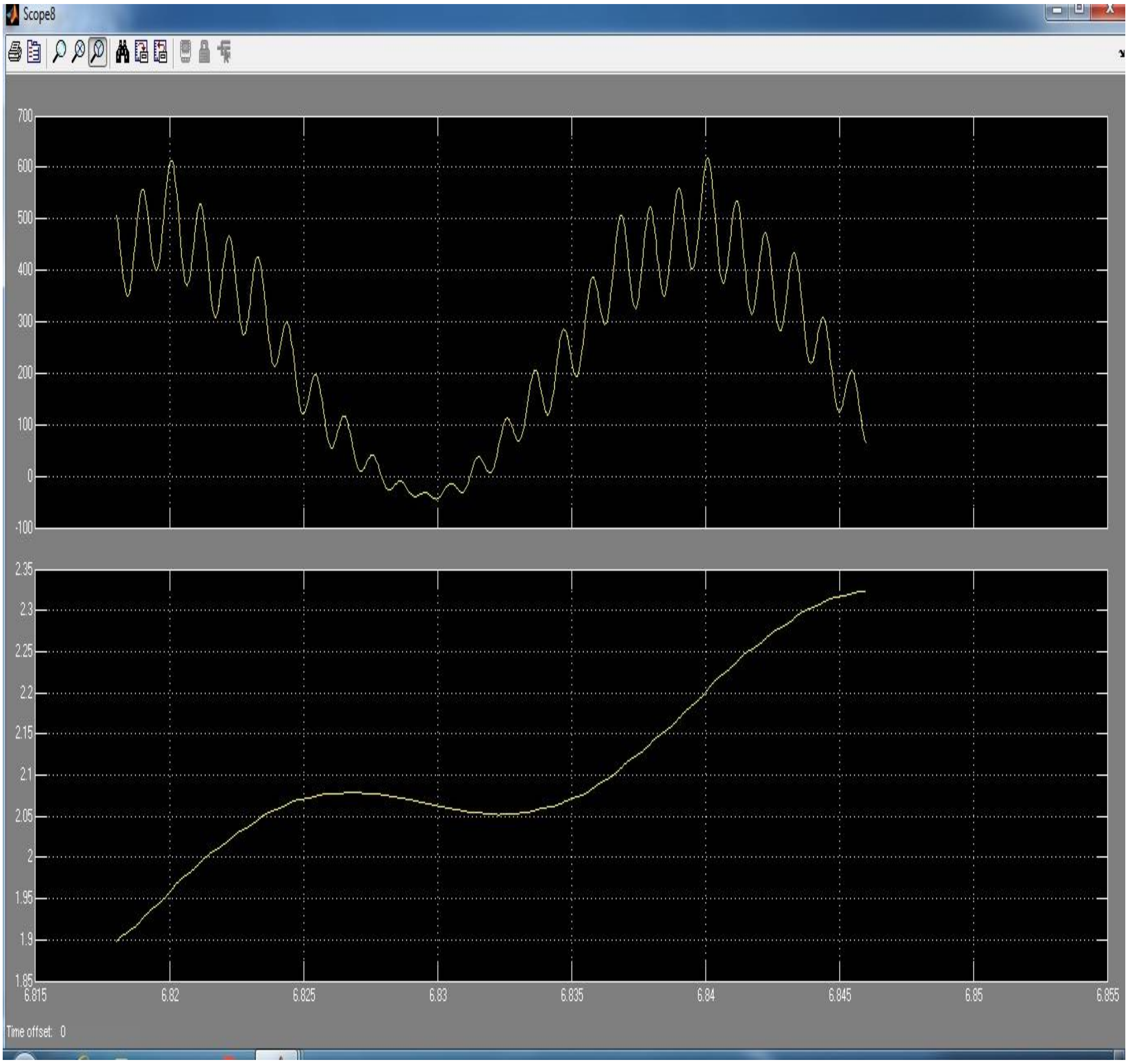

Fig 5 Torque in N-m and speed in rpm both are measured against time in seconds. First curve torque V/S time. Second curve speed V/S time

V. CONCLUSION

As given in figure 4 and figure 5, torque production is improved but high voltage increases risk and may cause high temperature problems. Power electronic transformers are cheaper compared to their conventional counterparts but any claim on cost reduction without any practical experimentation would be dubious.

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REFERENCES

[1] Ashish Shukla, Durga Sharma, Vishwanath Prasad Kurmi "Enhancement of speed of the electrical vehicle using power electronic transformer" International journal of advanced research in electrical, electronics and instrumentation engineering, 2018.

[2] S.Alepuz,F. Gonzalez Molina, J Martin Arnedo,J A Martinez Velasco "Time domain model of a bidirectional distribution electronic power transformer" International conference on power systems transients Vancouver Canada 2013.

[3] Saurabh Chauhan "Motor torque calculations for electrical vehicles" INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH VOLUME 4, ISSUE 08, AUGUST 2015.