“To Recover Energy Gained from Matching Long Cable using Synchronous Modulation in an Inverter Fed Motor Drive ’’

Sameer Raut
Department of Electrical Engineering, Priyadarshini College of Engineering, Nagpur, India
M. Tech Student (IDC)-SAMEER.S.RAUT
E-Mail: raut.sameer65@gmail.com

Abstract - The inverter-fed motor drives generate fast-switching voltage pulses. There generated high voltage pulses cause damage to the motor cable insulation as well as to the motor winding. A general protective measure is the use of a passive filter, such as RC and RLC filter. However, passive filters are bulky and lossy, therefore we are using an active filter with an energy recovery module, which perform the same function as passive filter but consume much less power .In these project we are comparing the model with filter and without filter.

Keyword *- Impedance, insulation, inverter, mismatch, motor, pulse, pulse width modulated, reflection, rise time, stator, transients, voltage.*

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I. INTRODUCTION

while inverter-fed motor drives provide flexible speed control, their generated high-frequency voltage pulses cause destructive voltage spikes that would accelerate the deterioration of the motor and the cable connecting between the motor and the inverter. Such phenomenon is due to the long transmission line effect. When a voltage pulse is launched to a long cable, part of it could reflect back to the inverter at the motor terminal. The reflection magnitude is determined by the characteristic impedance of the cable and the equivalent impedance of the motor. If the characteristic impedance of the cable equals the motor impedance (i.e., matched condition), no voltage reflection will occur. Conversely, if the two impedances are different (i.e., mismatched condition), voltage reflection will occur.

There are two remedial measures put in place to protect the motor against insulation damage. The first one is to use oversized motors or inverte. The second one is to use passive filter networks connecting to the entire drive system.

This paper extends the concept by replacing the clamping resistor with an energy recovery module. Instead of dissipating the energy in the clamping resistor, a converter with its switching pattern being synchronized with the inverter output voltage pulses is used to recycle the energy gained from voltage suppression back to the drive system, resulting in a significant reduction in the overall power consumption.

II. RESEARCH OBJECTIVE.

- The output voltage of the inverter.
- Input voltage of the motor.
- Power loss in the filter
- Power gained from the filter by the energy recovery module
- Efficiency of the motor

III. MATHEMATICAL MODEL

Simulation in MATLAB

1. With filter
2. With proposed filter (filter and energy recovery model)

1V. BLOCK DIAGRAM WITH FILTER

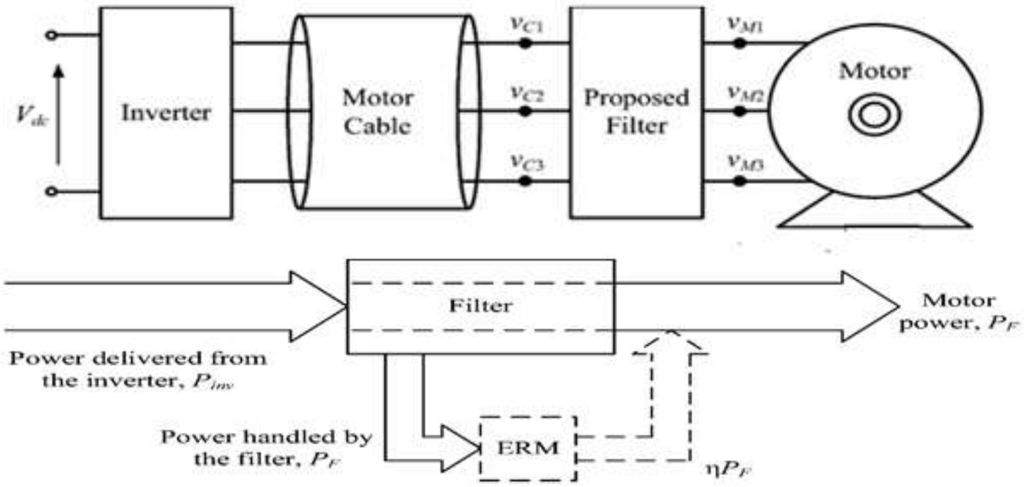


Fig1Power flow of the motor system with the proposed filter

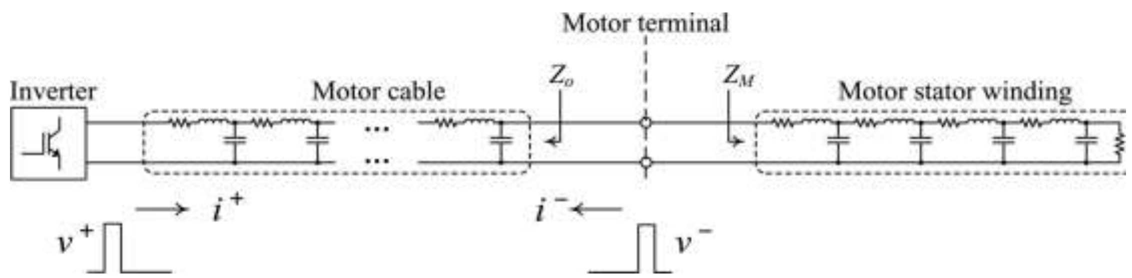
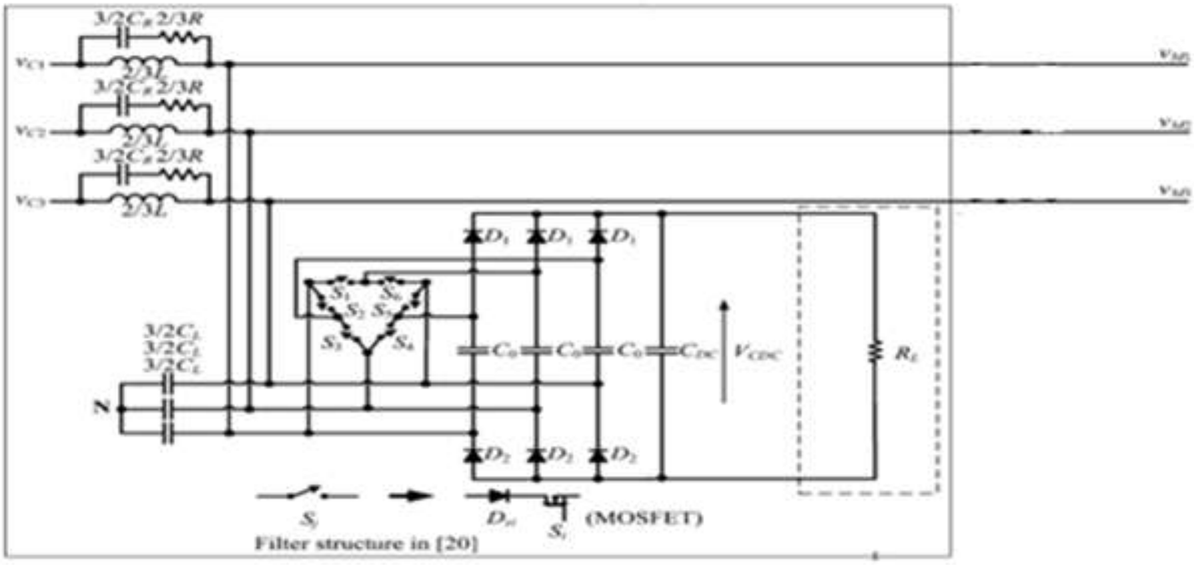


Fig 2. Motor drive system.

V1. CIRCUIT DIAGRAM OF FILTER



V. SPECIFICATION

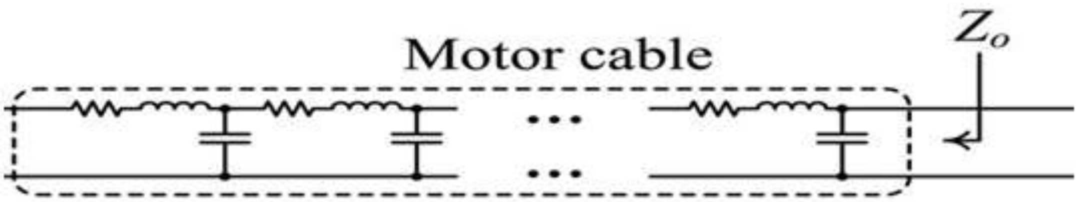
1) Inverter
2) Motor cable
3) Filter
4) Motor
5)

Inverter

The design comprises of single phase to three phase inverter.

- The input supply voltage to the inverter is 440 V.
- The switching frequency of the inverter is 10 KHz
- The power component used in the inverter is IGBT and diodes.

CABLES



The cable is formed by connecting ten cable sections. In electrical, impedance matching is the practice of designing the input impedance of an electrical load or the output impedance of its corresponding signal source to maximize the output power or minimize signal reflection from the load.

In the case of a complex source impedance Z_S and load impedance Z_L, maximum power transfer is obtained when

$$Z_S = Z_L^*$$

Where Z_S represents the characteristics impedance of a transmission line.

The cable impedance is calculated by using the following formulae.

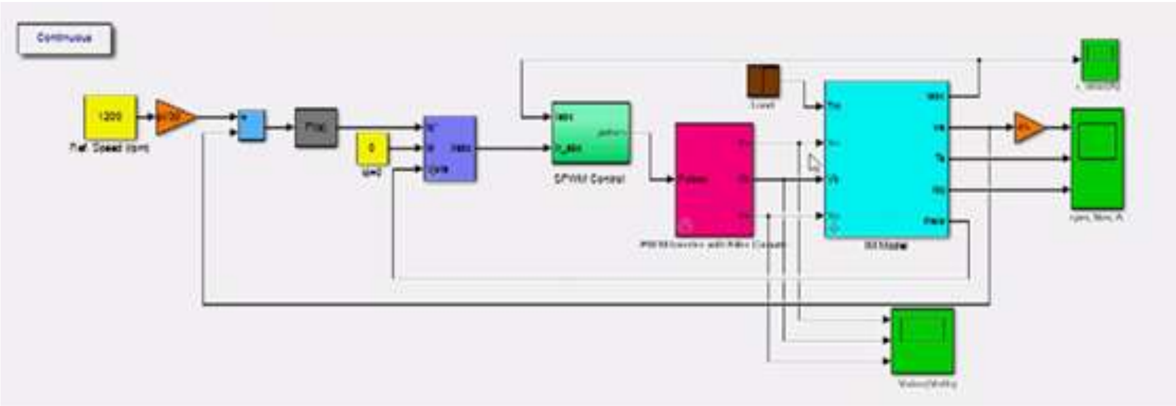
$$Z_o = \sqrt{\frac{L_C}{C_C}}.$$

Why Choose the Lowest Impedances Cables? Engineers should select the VFD cables with the lowest impedance possible. This is done for two main reasons. First, when the conductor impedances is lower, maximum power is transferred from the VFD to the motor to do useful work, with only a small amount of energy reflected. However, if there is a substantial mismatch between the impedances of the cable and motor, damaging reflected wave voltages As generated, and energy is lost. This reduces the stress on the motor windings and cable, and leads to greater system reliability and life.

FILTER

Filters are frequently used to achieve impedance matching in telecommunications, radio engineering and in inverter fed motor drive system. In general, it is not theoretically possible to achieve perfect impedance matching at all frequencies with a network of discrete components. Impedance matching networks are designed with a definite bandwidth, take the form of a filter, and use filter theory in their design. The commonly used filter in the drive system are RC filter ,RLC filter and proposed filter. Passive filters, such as RC and RLC filters, have been proposed to be installed at the motor terminals to match the surge impedance of the cable, which could significantly attenuate the overvoltage at the motor terminals.

VI. SIMULATION MODULE WITH FILTER



VII. SIMULATION RESULT

Inverter output:-

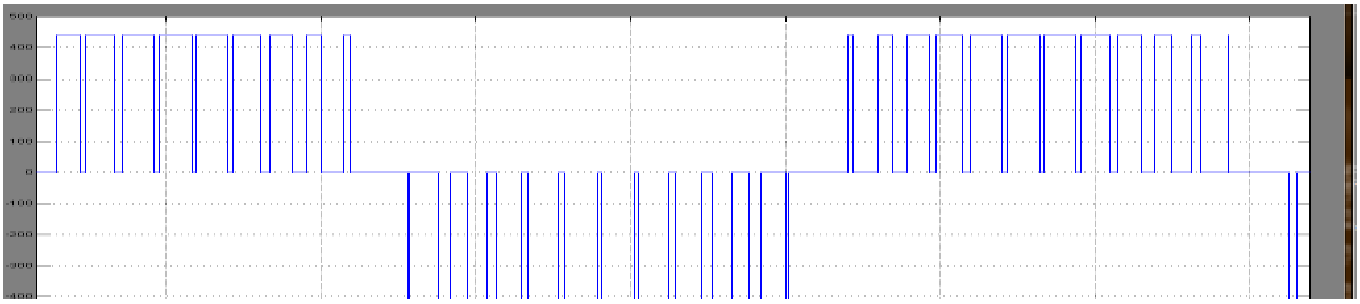


Fig. 2 : simulation result of inverter output voltage

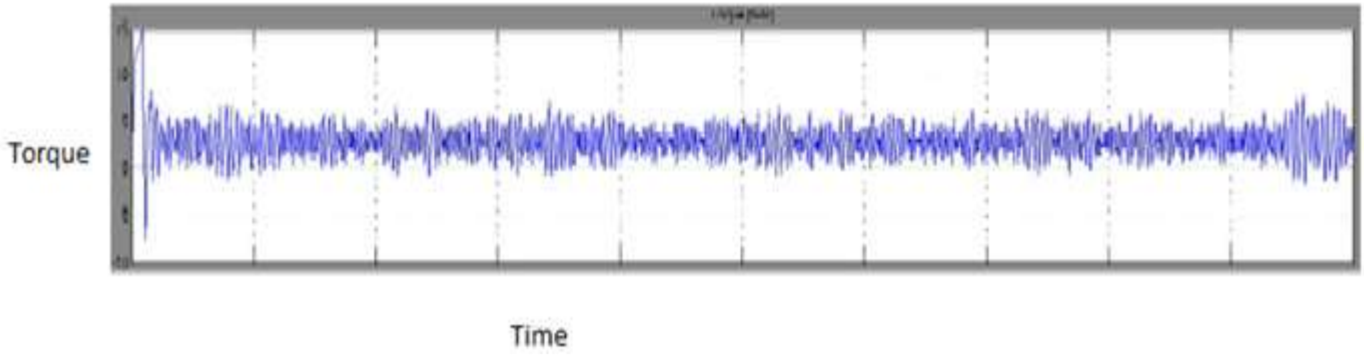
VIII. Characteristics of induction motor

a) Speed

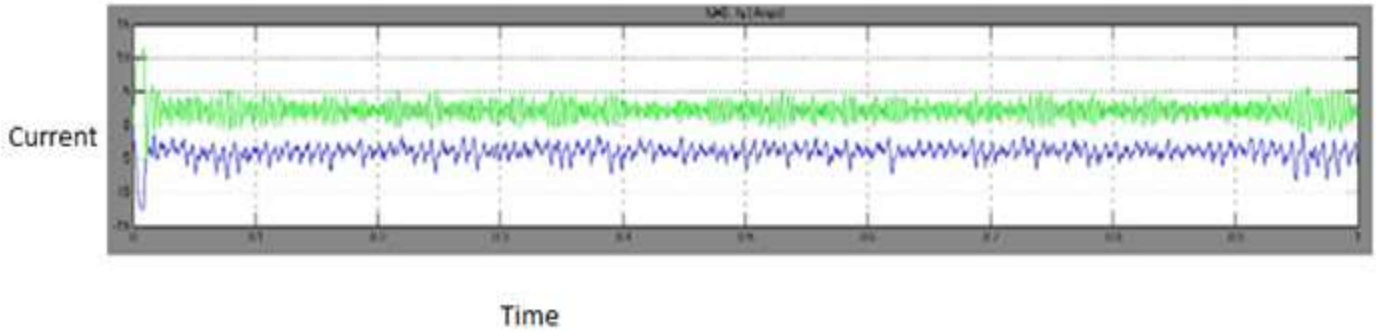
Speed

Time

b) Torque



c) Current:-



IX. MOTOR PARAMETER

Induction motor	3phase,5hp,415v,50hz,4pole
Rated speed	1420rpm
Stator current	7.9 Amp.
Rotar current	4.0 Amp.
Stator magnetizing. inductance ($L_{m)}$	0.1542H
Magnetizing reactance (X_m)	48.44 Ω
slip	5.30%
Synchronous speed	1500 rpm

X CONCLUSION

This paper extends the previously developed active motor terminal filter. The filter is not only designed to clamp the maximum motor terminal voltage at a safe level and alter the wave front of the pulses at the motor terminal to improve the inter coil and inter turn voltage distributions in the motor, but it can also recover the energy gained from suppressing the over voltage due to the long-transmission line effect and regenerate back to the system. A synchronous modulation scheme that makes the modulation pattern of the output of the energy recovery module similar to the inverter output has been proposed. The implementation requires a low-cost microcontroller only. The proposed filter can give the same functions as the one in and has much lower energy losses. .

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