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Modeling and Simulation of Automatic Three Point Starter

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***Abstract*—DC motors are commonly started with the starter because in the beginning of it; due to the absence of back EMF heavy current will pass through it which may burn the DC motor. Various method are employed for limiting the current into safe value such as voltage level variation, addition of the external resistance etc. the three & four point starter are employed to the machine which add up the external resistance to the circuit which bring the current in the safe value limit . In this paper a simulation model is proposed which shows that all the resistances gradually removed from the circuit, as the back EMF is generated. In this paper automatic 3 point starter method is proposed which gives automatic function of starter of DC motor.**

Keywords— DC motor, Back EMF,Three Point Starter.

I. INTRODUCTION

Dc machine are broadly classified on the basis of their starting, the arrangement of field and armature winding with respect to each other (series, parallel or compound). But all the dc motor are required a starter for the starting purpose either it may be three point starter or four point starter. The three point starter adds an external resistance in series with the armature winding which limits the current.

a. Necessity of Starter

In DC machine back EMF is generated due to the rotational motion of the armature in the field but at the beginning rotor or armature is at the zero rpm so, no back EMF will be present in the machine .

$$E_b = 0 \quad (1)$$

$$V_t = E_b + I_a R_a \quad (2)$$

$$\frac{V_t - E_b}{R_a} = I_a \quad (3)$$

Where
E_b itself maintain the value of Ia, but because of absence of E_b heavy current will pass through it which is in multiple of rated current .The starters are used for controlling the current in safe value like three point starter and four point starter.

b. Starting of DC machine with three point starter

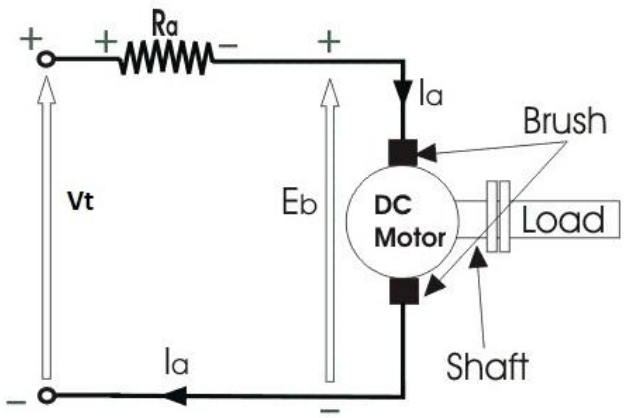
As the calculated amount of resistance is add up external in series with the armature winding. At the beginning of dc motor, the back EMF will be zero, as the speed at armature increases, back EMF will also increase.

Due to lack of back EMF a heavy current will pass through the armature winding which will be multiple of rated current and it may burn due to the I^2R losses in the motor.

In three pointer starter, three resistances are added up in series with external circuit. R1, R2 and R3 as the motor generate the back EMF, resistance are gradually cut down in three steps after the particular interval of time and rated current will pass through the armature winding, it runs on the rated speed Basically three resistors limit the heavy current. In the lack of external resistance, motor may have various adverse effect such as winding failure, heavy torque is experienced by the dc motor.

. $T \propto \emptyset I_a$

Torque is directly proportional to the current.



$$V_t = E_b + I_a R_a \quad (4)$$

$$V_t = I_a R_a \ (E_b = 0) \quad (5)$$

$$\frac{V_t}{R_a} = I_a \text{(Heavy current)} \quad (6)$$

By use of starter:

$$V_t = E_b + I_a R_a + I_a R_{ext} \quad (7)$$

$$V_t = E_b + (R_a + R_{ext}) I_a \quad (8)$$

When,

$$V_t / (R_a + R_{ext}) = I_a \quad (9)$$

High value of Rext reduced the current in safe limit. In automatic three point starter , motor are direct switched on from the supply and cutting off of resistance is done automatically by some time delay instead of changing lever or switch one- by- one.

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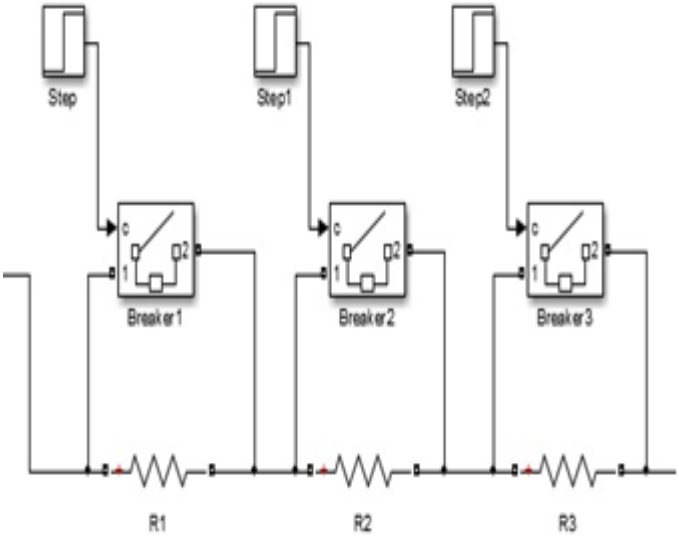
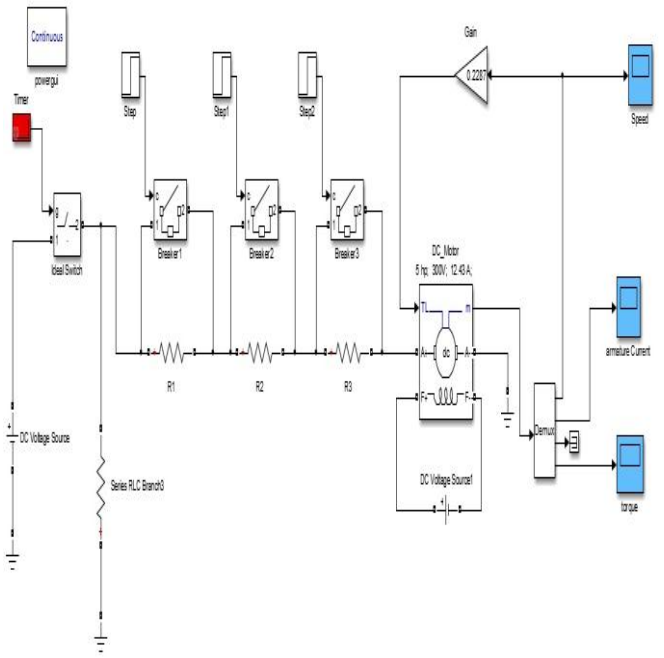
II. SIMULATION

Three point starter theory are widely described in many books by different author instead of discussing it, In this paper we have developed a Simulink model of automatic three point starter in Matlab to explain the concept of three point starter practically. Many blocks are required, each block have their own importance while designing the starter. Mainly arrangements of breaker are to be synchronized in such a manner that each resistance out of three is gradually cut down one after one sequentially.



Each breaker are connected in parallel with the specific resistance, these are arranged in series with the armature winding. Initially for breaker 1 are in open '0' position which are step with particular time interval to '1' position and resistance R1 are by-passed with the short circuit. R1 is cut down from the external resistance. Similarly R2 and R3 by breaker 2 & breaker 3 are also cut down with particular time interval with each other. The whole resistances are cut down in three steps.



III. CALCULATION

Armature supplied with rated current and Dc motor runs satisfactorily.

$$V_t = E_b + I_a R_a$$

At starting,

$$V_t = I_a R_a \ (E_b = 0)$$

$$V_t = 300V, \qquad P=5\ h.p$$

$$I_a = \frac{5 \times 746}{300} = 12.43A$$

$$\frac{V_t}{I_a} = R_a = \frac{300}{12.43} = 24.12\Omega$$

$$I_a = Rated\ current$$

$$2 \times I_a = 2 \times 12.43 = 24.86A$$

$$\frac{V_t}{I_a} = R_{amax} = \frac{300}{24.86} = 12\Omega$$

$$Change\ in\ resistance = R_a - R_{amax}$$

$$24.12\Omega - 12\Omega = 12\Omega$$

12 Ω reistance are needed for adding to external circuit

$$R_T \rightarrow total\ resistance$$

$$R_T = R_1 + R_2 + R_3$$

$$R_T = 7.7\Omega + 3\Omega + 1.21\Omega = 12\ \Omega (approx)$$

$$R_1 \rightarrow 7.7\Omega$$

$$R_2 \rightarrow 3\ \Omega$$

$$R_3 \rightarrow 1.21\ \Omega$$

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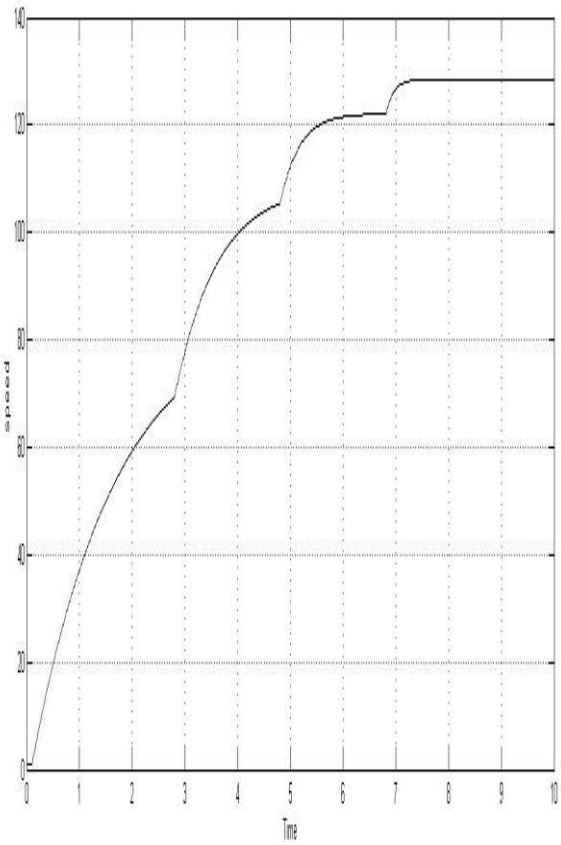
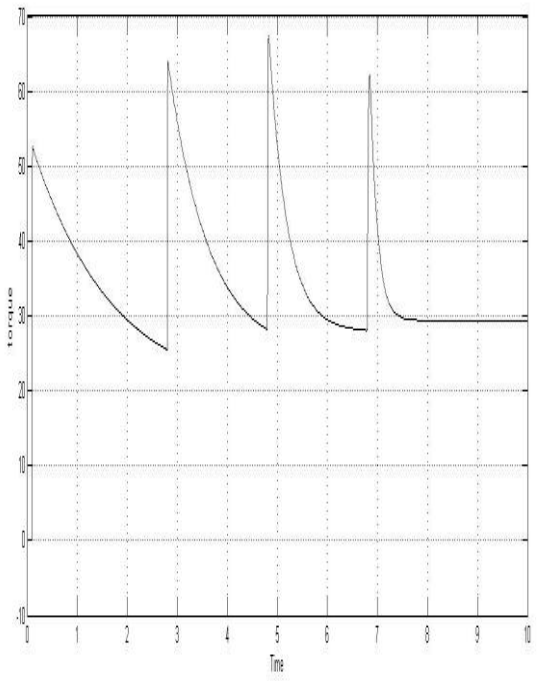
IV. RESULT

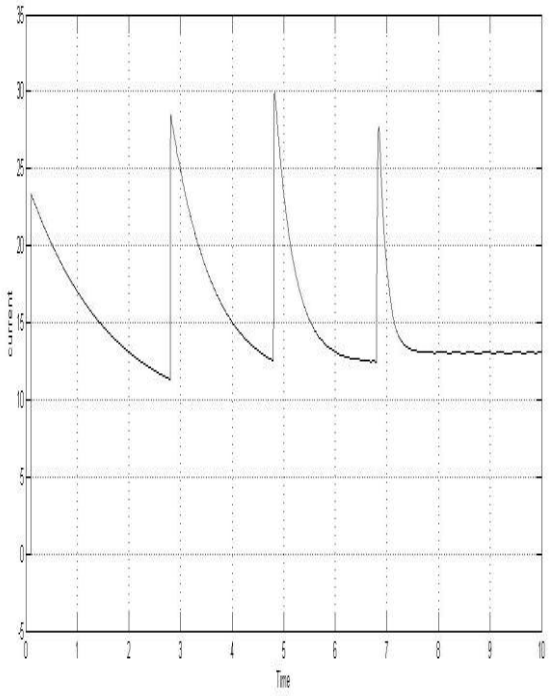
a. Speed Vs Time



b. Torque vs Time



c. Current vs time



V. CONCLUSION

In traditional three point starter method we require manual process for changing the position of lever/handle or switch of three point starter to cut-off the resistance from the armature circuit. In this paper an automatic three point starter method is proposed in which resistances are cut-off after particular interval of time one by one from the circuit automatically.

VI. REFERENCES

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