User's Manual

FOR

ET-DCM
DC MOTOR CONTROLLER

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D.C. MOTOR STUDY CARD

An electric motor is a machine which converts electrical energy into mechanical energy of rotation.

PRINCIPAL

the action of an electric motor is based on the principal that when a current carrying conductor is placed in a magnetic field it experiences a torque coil. The direction of this mechanical force is given by Fleming`s left hand rule and its is given by

F =B.I.L NEWTON

CONSTRUCTIONAL FEATURES

Like any other electrical rotating machine, a DC motor has two main parts:-

1. The stator, &
2. The Rotor

The stator is the stationary member and consists of the field system. The rotor is the rotating member, which houses the armature windings. The rotor of a DC machine is also called armature.

The Rotor and the stator consist of the following five parts:-

1. **ARMATURE**: - The armature ABCD consists of a large turns of insulated copper wire wound over a soft iron core.
2. **FIELD MAGNET**: - The magnetic field is supplied by a permanent magnet NS.
3. **SPLIT - RING OR COMMUTATOR**: - These are halves of the same ring. The ends of the armature coil are connected to these halves which also rotate the armature.
4. **BRUSHES: -** These are two flexible metal plates or carbon rods B1 and B2, which are so fixed that they constantly touch the revolving ring.
5. **BATTERY: -** The battery consists of a few cells of voltage V connected across the brushes. The brushes convey the current to the rings from where it is carried to the armature.

WORKING

Let us suppose that the battery sends current through these armature in the direction in fig. 1. Applying Fleming's left hand rule. CD experiences a force directed outwards and perpendicular to it. These two forces being equal, unlike and parallel from a couple. This couple rotates the armature coil in the anti clockwise direction. Thus to have current distribution on one side of the armature the same at any time, it is necessary that there should be a change in the direction of current in these conductor while passing under the brushes. Otherwise the armature will turn only by 90 degree and they're after stop rotating. Therefore.

the continuous rotation there should be a change in the direction of current in conductors passing under the brushes. This process of current change is called COMMUTATION. After the Coil has rotated through 180 degree the direction of the current in AB and CD is reserved. Now CD experiences an outward force and AB experiences an inward force. The armature coils thus continues rotating in same i.e. anti clockwise direction.

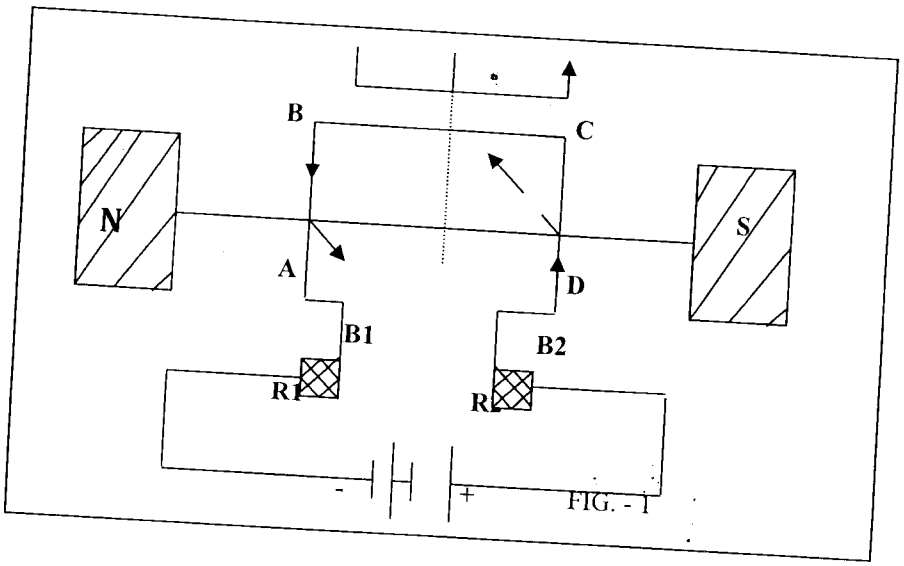


FIG. - 1

SPEED OF A DC MOTOR

From the voltage equation of a motor, back E.M.F is given by: -

EB = V-(Ia.Ra)

or $\not{O}$.Z.N.P/ 60 =V-(Ia.Ra)

thus, speed of the DC motor is:-

N=V-(Ia.Ra) / $\not{O}$ * 60A/Z.P r.p.m

Now, V - (Ia.Ra) = EB

Therefor, N = EB / $\not{O}$ *60A/Z.P rmp

Or N=K (EB) / Ø ----- equ. (1)

where,

N= speed of the DC motor

$\not{O}$= Magnetic lines of flux

EB = Back E.M.F

This shows that is directly proportional top back E.M.F (EB) and inversely to flux O.

SPEED REGULATION

The term speed regulation refers to the change in speed of motor with change in applied load, other conditions remaining constant. The speed regulation is defined as the change in speed when the load on the motor is reduce from rated value to zero, expressed as per cent of the rated load speed.

Thus, % speed regulation + N.L speed - F.L speed / ϕ *100 = DN / ϕ *100

TORQUE AND SPEED OF A DC MOTOR

The speed of a DC motor depends on torque which in turn depends on flux and armature current. From equation (1) we see that increase in flux would decrease the speed but increase the armature torque. It cannot be so because torque always to produce rotation. If torque increase, motor speed must increase rather than decrease. The apparent between the following two equations can be explained as:

$N = K (V - Ia. Ra) / \phi = K. EB / \phi$ ----------equ. 2 (a)

AND $TA = \phi . IA$ --------equ. – 2 (b)

Suppose that the flux of a motor is decreased by decreasing the field current.
Then, following sequence of events takes place.

1. **Back E.M.F EB (= N. O/K) drops instantly (the speed remains constant because of inertia of the heavy armature).**
2. Due to increase in EB, IA is increased because IA = (V – EB)/ RA. Moreover, a small reduction in flux produces a proportionately large increase in armature current.+
3. Hence, in equation. TA = O. IA, a small decrease in 0 is more then counter balanced by a large increase in IA, with the result that there is a net increase in TA.
4. This increase in TA produces an increase in motor speed. It is seen from above that with the applied voltage V held constant, motor speed varies inversely as the flux. However, it is possible to increase flux and, at the same time, increase the speed provided IA is held constant.

DESCRIPTION OF THE CARD

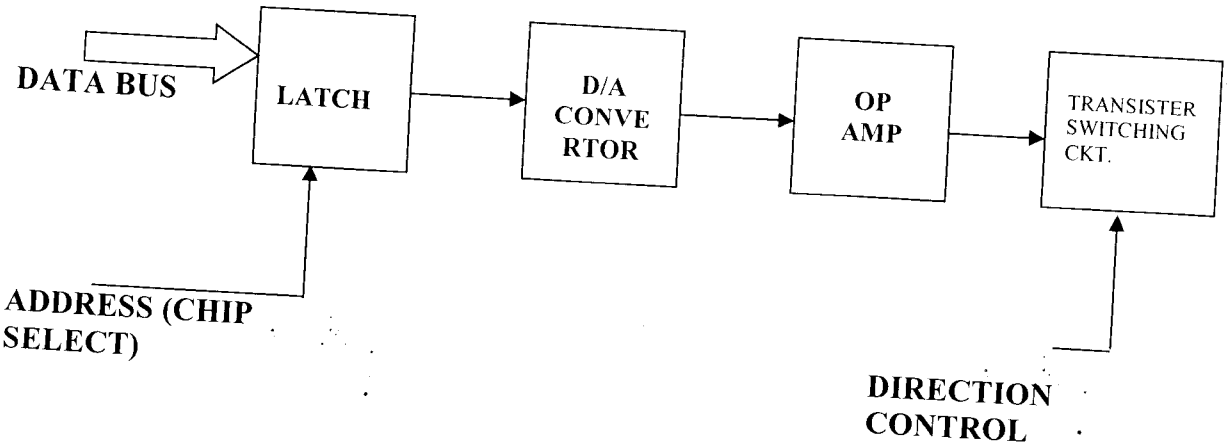
The card has been designed to allow the students to study as to how the speed and direction of rotation of the motor can be changed. The card uses a D/A converter DAC0800 to control the speed.

The higher the current which flow through the winding of the motor, the higher is the speed. The digital data is fed to the DAC 0800 through latch 74LS273. This data input to the DAC remains latched unless it is changed. The DAC outputs the current depending on the digital input. This outputted current is converted to voltage and is fed to the operational Amplifier. The output of the OP-Amp is reduced using a divider circuit . This

reduced output drives a transistor with motor in series with the collector circuit. The higher the current flower through the winding, the higher is the speed of the motor.

The digital data outputted at address 40 is also displayed by 8 LED s as D0 to D7 through 74LS245.

The following block diagram explains the above process.



DIRECTION

The direction of the rotation can be changed by changing the direction of the current through the winding of the DC Motor. This is done by a switch SW1.

ADDRESS

The card has on I/O mapped addressed 40 Hex. The motor will run when the data corresponding to the speed desired is outputted on the address 40.

Please note that the motor has certain inertia, which needs to be overcome. Therefore it may be the case that the motor does not start rotating unless a minimum digital value is outputted. This may very from one motor to another.

SETUP FOR THE EXPERIMENT FOR ALL BASIC & ADVANCE 8085 KITS WITH LED / LCD DISPLAY

STEP 1:-Connect 50 pin FRC connector from interface card to 8085 Microprocessor kit.

STEP 2:- Connect +12V (Green Wire) , -12V (White Wire) and GND to the Study Card either through a separate power supply or through a connector cable from the 8085 Kit to the four pin connector of the Study card (Only Advance 8085 Kits have built in +5V, +12V and -12V power supply, The basic Kit has only +5V supply which gets connected to the Kit through the 50 pin FRC cable, so a separate power supply is required to give +12V and -12V). Switch on the supply and press reset on the Kit.

STEP 3:-Enter the program given below by using appropriate commands.

STEP 4:-Execute the program using <GO> key as explained in the Kit manual.

STEP 5:-Observe the results on the LED's and the speed of the motor.

PROGRAM

ADDRESS	PROGRAM	OBSERVATION
2000	3E FF	
2002	D3 40	The motor rotates.
2004	EF	

1 Repeat the same program after changing the data at 2001 to 88. Observe that the speed has reduced.

2 Repeat the same program after changing the data at 2001 to 00. The motor will stop.

3. Now change the direction of the switch SW1, and repeat the above process from SW1. The motor will now rotate in the other direction.