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2796 Culver Ave., Dayton, Ohio 45429
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HOW TO PLOT SPEED/TORQUE AND CURRENT/TORQUE CURVES

ENGINEERING BULLETIN E-1

On every bulletin sheet there is sufficient data for you to plot the speed/torque and current/torque curves for each armature available in that particular motor size.

Even though ratings are provided for each motor, seldom will you ever operate at that point. You really must draw at least a speed/torque curve to tell the speed at which the motor is going to run. Then, plotting the current/torque curve on the same graph will tell you the amperes required at your particular load point.

For a D.C. permanent magnet motor, the two "curves" are simple straight lines, so only two points of data are required for each curve (or straight line) for you to draw them. These data points are listed on the back side of every motor bulletin sheet. The two points you need to plot the speed/torque curve are the **No-Load Speed** (point **A**) and the **Stall Torque** (point **B**). To plot the current/torque curve will require the **No-Load Current** (point **C**) and the **Stall Current** (point **D**).

You may prefer to plot this data on standard 8½ x 11", ¼ inch quadrille paper, or on regular graph paper. In any event, we have selected the model DMR-10 motor, found on bulletin 150A100. Turn to that particular sheet and find the charted data on the back side of the bulletin for the 150A100 motor, at 27 VDC input.

From the Basic Motor Data Chart (Bulletin 150A100) note that the no-load speed for the DMR-10 is 10,550 rpm. This is point **A** on the curve in Illustration 1.

The stall torque value shown in the chart is 21.1 oz. in. and this is point **B**. Plot these two points on your graph paper and connect them with a straight line. This line (or curve as it's called) shows the speed versus torque characteristics of the DMR-10 motor at 27 VDC input.

Continuing with the data, plot point **C**, the **No-Load Current** of .234 amps. and the **Stall Current** of 6.3 amps. at point **D**. This last point is located directly above the stall torque, point **B**. Connect points **C** and **D** and you now know the current versus torque characteristics of this motor.

It becomes obvious, once you have plotted these curves, that no matter what load you apply you can immediately tell at what speed and current the motor will run. For example, suppose you will be using this motor at a load of 2.0 oz. in. From the curves you have just drawn, you can see that the motor will run at approximately 9500 rpm and it will draw 0.75 amps. from the supply.

Going even further, suppose your application has an intermittent loading of 7.5 oz. in. How much will the motor slow down during that load condition, or how much current must the supply produce? From your plot you can see that the motor will slow down to about 6800 rpm and demand about 2.3 amps. from the supply.

ILLUSTRATION 1

SPEED/TORQUE AND CURRENT/TORQUE CURVES
150A100-10 (DMR) @ 27 VDC

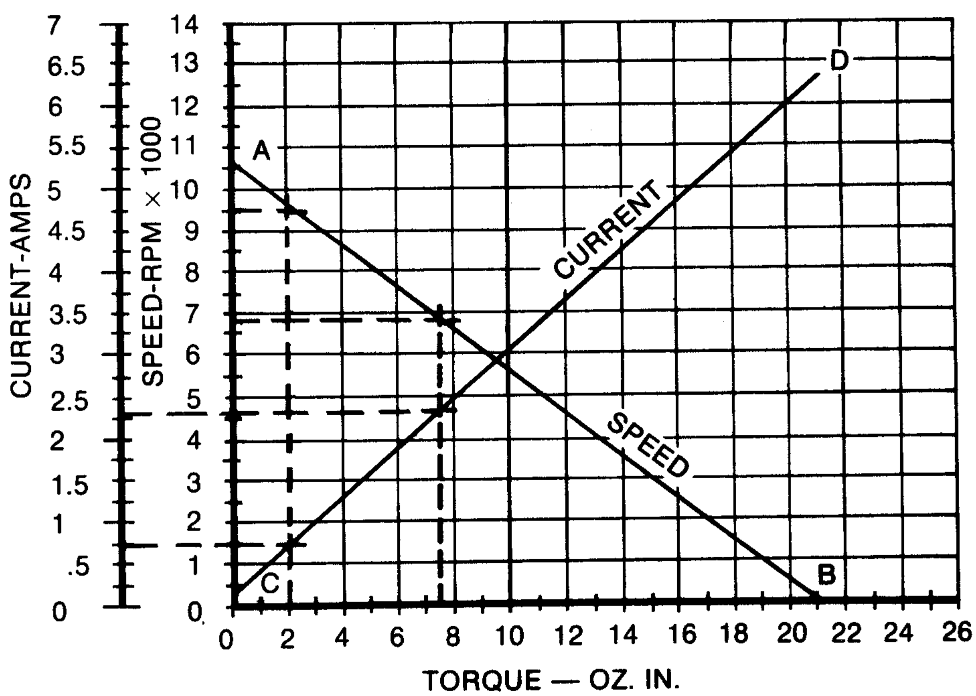

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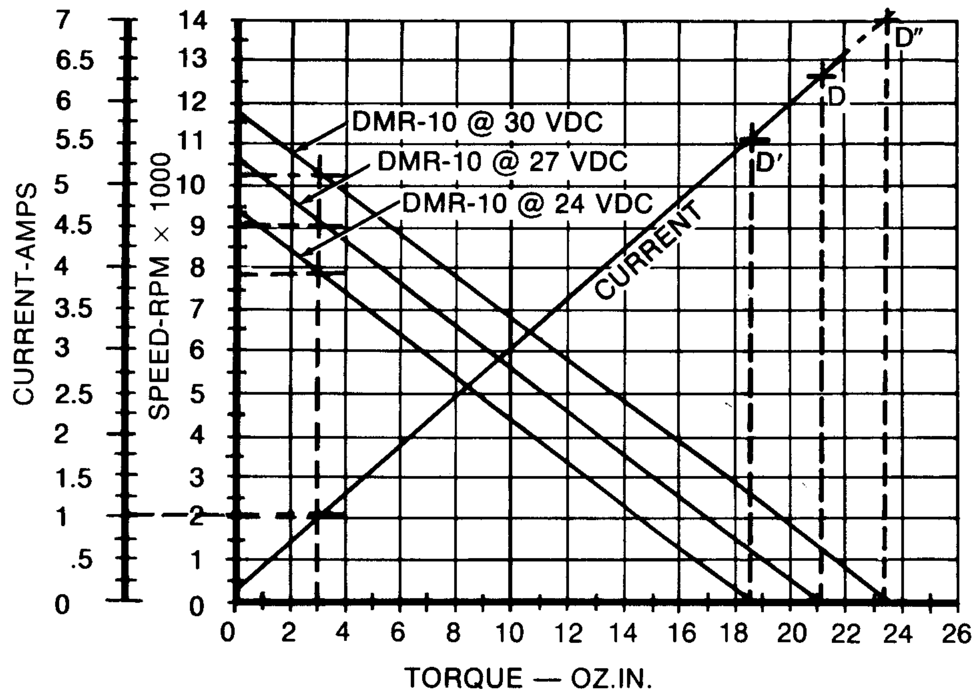
ILLUSTRATION 2

SPEED/TORQUE AND CURRENT/TORQUE CURVES
150A100-10 (DMR) @ 24, 27 & 30 VDC



In all probability, the power supply will not provide a nice stable 27 VDC all the time, or maybe it is not a 27 VDC source but 24 VDC instead. What do you do with the data now? No problem!

The effect of such a change is easily calculated because permanent magnet motors have certain characteristics which are:

1. The **no-load speed** is directly **proportional** to the **voltage**.
2. The **slope** of the **speed/torque curve remains constant.**
3. The **current/torque** curve **does not change** when you vary the voltage.

Since the **no-load speed** is directly proportional to voltage, the no-load speed at 24 VDC would be calculated by dividing the no-load speed (10,550 rpm) by 27 VDC (rated input voltage) and multiplying that number by 24 VDC — the new voltage. In this instance, the no-load speed at 24 VDC would be 9377 rpm. Now plot this new point (see Illustration 2) and draw a line through it, parallel to the 27 VDC curve. This is the performance of the motor at 24 VDC. Remember, the current/torque curve does not vary with voltage, so the current will stay the same.

Going one step further, let's assume this is a military application and the power supply may put out as much as 30 VDC. What will happen? Well, the new no-load speed can be calculated by dividing 10,500 rpm by 27 VDC and multiplying that number by 30 VDC. The new no-load speed is then 11,722 rpm. Plot this point and draw a line through it parallel to the 27 VDC curve. Each of these curves tells you what the motor will do at that particular voltage. From Illustration 2 it's obvious what the motor speeds will be if the load was 3 oz. in. and the voltage varied between 24 and 30 VDC: 7800 rpm to 10,200 rpm. Right? The current — a steady 1.0 amp. nominal.

As a matter of general interest, the stall torque value of the motor did change from point D′ to a high at point D″ (approx. 18.5 to 23.3 oz. in.) because the stall current (and stall torque, too) is proportional to the applied voltage. Apply twice the voltage and you get twice the stall current — half the voltage and you get half the stall current. Why? Because when it is not rotating (e.g. — stalled) the armature appears in the circuit as a resistor.

Got any other questions? Call our Application Engineering Group for help. We promise to give you prompt attention.