DC BRUSH Motors
DMN Series

Structure

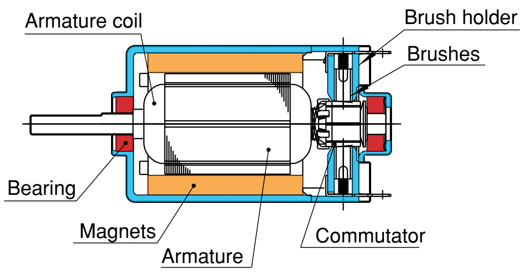


Fig. 1

- **Brushes**
  The brush is an important part that serves as a commutating mechanism. The brush's service life (in accordance with wear) will be the service life of the direct-current motor.
- **Commutator**
  In general, copper is the material used, but to counteract how it softens at high temperatures, a small amount of silver is mixed with it.
- **Armature coil**
  In general, electric wire known as magnet wire is used. Wire diameter is selected in accordance with the motor's specifications, and the wire is connected to the commutator bar by means of welding, soldering or other such methods.
- **Armature**
  For the armature, magnetic steel sheet is used to increase magnetic flux density.
- **Magnets**
  Broadly speaking, the magnets used in the motor can be classified in terms of whether they are ferrite, alnico, rare earth, etc. Magnets are selected in accordance with usage purpose, based on their features.
- **Bearing**
  There are ball bearings and sleeve bearings, and they are used in accordance with purpose.
  The ball bearing is the type that is appropriate for uses involving large bending loads.

Current and rotating torque characteristics

The magnet DC motor has dropping characteristics (rotation speed) and rising characteristics, as shown in Figure 2. When applied voltage V is changed, as shown in Figure 2, torque rotating speed characteristics will be proportional to the value for V, but current torque characteristics will only change very slightly. (For details, please refer to the relational expression for current and torque rotating speed.)

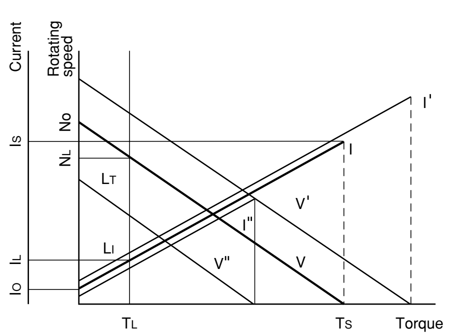


Fig. 2

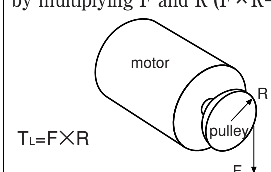
How to view characteristics

As shown in Figure 2, at applied voltage V, when load torque T_L is added to the motor, rotating speed and current will be N_L and I_L, respectively. When V has been changed to V'V'', the result can be similarly sought. No-load rotating speed, No, and stalling (starting) torque, Ts, will be proportional to the applied voltage; thus, the values for when a 24V motor, for example, is used at 20V or 18V will be on the order of those shown in Table 1. (No-load current Io will be sufficiently small compared with the stalling current and can thus be disregarded.)
When changing the rated voltage substantially (from 24V to 6V, for example), it will be necessary to depend on actual measurement.
However, use at something other than the rated voltage could cause abnormal brush wear and startup malfunctions. Thus, we ask that you confirm the usage conditions.

Voltage	No-load rotating speed No	Stalling torque Ts	Stalling current Is
24V	5000r/min	40mN-m	1.0A
20V	$\frac{20}{24}\times5000$ 4166	$\frac{20}{24}\times40$ 33	$\frac{20}{24}\times1$ 0.83
18V	$\frac{18}{24}\times5000$ 3750	$\frac{18}{24}\times40$ 30	$\frac{18}{24}\times1$ 0.75

Table 1

Explanation of Terminology

Term/Symbol	Content
No-load rotating speed No	Rotating speed with no load
No-load current Io	Input current with no load
Stalling torque Ts	Max. value for motor-generated torque. In general, a DC motor's stalling torque is equal to its starting torque.
Load torque T_L	As shown in Figure 3, when a pulley with radius R is attached to the motor and force of F is applied to the pulley's circumference, the torque generated, T_L, can be derived by multiplying F and R ($F\times R=T_L$).  Fig. 3 Note : Using the lock with voltage applied could cause burnout.

Relational expressions for torque, rotating speed and current

Relational expressions are as follows.
If the no-load rotating speed from formula 1 is taken to be No, when load torque T_L is zero, there will be no load; thus, if $T_L=0$, the following will be the case.
No-load rotating speed No will be determined from the size of the motor's friction torque, T_O. If T_O is low, the no-load rotating speed from formula 3 will be roughly proportional to the applied voltage. In addition, stalling (starting) torque will equal the load torque when rotating speed N from formula 1 is zero, resulting in the following:
Starting torque will be roughly proportional to the applied voltage. Current will be as follows.

From this formula, when load torque T_L and friction torque are constant, the current will be constant with no relation to applied voltage. The no-load current will be the value that makes the load torque zero in formula 5, but friction torque T_O will change slightly, in accordance with rotating speed; thus, there will be some change caused by the applied voltage.
If motor output is designated as P (W), torque as T (N・m) and rotating speed as N (r/min), motor output P (W) will be as follows.

$P=0.105\times T\times N$ ……………………………Formula 6

N : Rotating speed　　T_O : Motor's friction torque
V : Applied voltage　　T_L : Load torque
r : Armature-circuit resistance　　K_1 and K_2 : Motor-specific constant

Operating Precautions

DC motors are compact and display high output, and their speed is easy to control. They may be driven by battery or any other power supply and are therefore also easy to use. However, inappropriate power supply may lead to burnout or abnormal brush wear.
Problems with power supply, installation, and general precautions and problems with a motor installed in-circuit will be described.

• Overload and lock-up

An excessive amount of load torque is applied during overloaded driving or when locked up, causing an excessive current flow with heat damage being incurred by the motor. Therefore, overloaded or locked-up use is to be avoided. (Locking up for 5 or more seconds results in damage to a motor. Do not lock up a motor for 5 or more seconds.)

• Applied voltage

Be sure to use a motor at its rated voltage (~~+IUVI~~), and avoid any surge voltage. We can specially manufacture motors designed with an electrical path protecting the motor from surges and reversed polarity. Please contact us for details.

• Applying non-rated supply voltages

Applying a voltage higher than the motor's rating results in a temperature increase, leading to heat damage or lowered service life. Scoring of the commutator surface by sparks and mechanical brush wear arising from vibration may also occur.
Applying a voltage lower than the motors rating may eventually result in the motor failing to start. This is due to the build up of carbon powder on the commutator.
Motors are manufactured for use within ~~+lOV~~o of their rated specifications.
Please contact us if you need to use motors outside their ratings.

• Brush wear promoted by power supply ripples

Brush wear may be mechanical wear due to brush and commutator abrasion or electrical wear due to sparking between the brush and commutator, the latter being the most common. Brush wear is there fore greatly affected by ripples in the power supply voltage, and use of general regulated DC is recommended, However, when rectifying AC for use by a motor, be sure to use full-wave rectification with a capacitor or similar element in a smoothing circuit.

• Ambient conditions

The service life of a DC motor is dependant upon its rectifying action.
Care must be taken to ensure good commutation, as dust, oil, gas, water, etc.
Water, etc, on the commutator surface results in poor rectification and increases brush wear.

• Changing the brush position

The brushes are generally fixed in position such that rotational speed and current characteristics are maintained equivalent in both clockwise and counter-clockwise directions. These are basically determined based on the position of the magnetic poles. Rotating the motor after not carefully relocating parts such as the brush holder (for fixing the brushes) or rear cover results in misalignment of the brushes and magnets. This will produce change in the above characteristics in the rotational direction or cause poor rectification, leading to abnormal brush wear. Therefore, changing of the brush positioning is to be avoided.

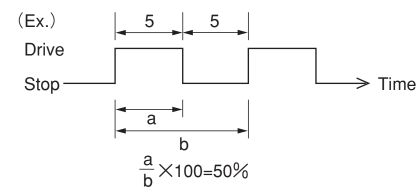
• Installed orientation

Motors are generally designed for use with a horizontal output shaft.
Special consideration must be given to components including bearings and grease washers when intended for an upward- or downward-facing output shaft. Please contact us for details.
Further, avoid installing a motor in a manner in which grease from the gear head would tend to enter the motor (e.g., with an upward-facing output shaft).

• Noise generation

Electrical noise is generated as a result of sparks from commutation between the brushes and commutator. Please contact us for assistance with lowering noise.

• Gear heads for intermittent drive



(Applles to 36G,43G,5C,and L)

Fig.4

The gearhead is assembled with a fixed shaft about which a gear revolves and transmits power. It is not suited to continuous drive. You should maintain the duty ratio between ON and OFF states at no more than 50%, with the maximum ON state not exceeding 5 seconds.

• Motor and gear head combination

When combining a gear head with a pinion shaft, gently fit the gear head on turning it right and left, being careful that the pinion and the gear in the gear head do not strongly clash with each other.
Using force will cause noise-producing scratches in the pinion and the gear. Scratches are Failures by a decreased service life and are the cause of unforeseen accidents.

• Load variation

Even with torque below the rated load, a motor will incur more damage than might be imagined if there is frequent load variation. Exercise caution with operating conditions and load restrictions.

• Insulation resistance

The insulation resistance of a brush motor will naturally continue to decrease as its running time increases. The figures for resistance given in the catalog are for a new motor.

• Service life

Service life depends greatly on operating conditions and environment.
Please contact us for details.

• Other aspects

Oil may seep out of the grease in the gear head depending on operating conditions, storage environment, etc, This does not present any problems in the use of the gear head.
However, contamination of the machine or equipment to which the geared motor is fitted may occur.