MOOG COMPONENTS GROUP

Application Note

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MCG DISTANCE - BASED TRAINING Document Number 104

MCG DISTANCE-BASED TRAINING - APPLICATION NOTE#4

KM - Motor Constant - "THE GREAT EQUALIZER"

One of the most often overlooked parameters of direct current motors (both brush and brushless) is the **Km** or motor constant. The motor constant or **Km defines the ability of the motor to transform electrical power to mechanical power** and is a valuable tool for the application engineer particularly for recommending a "best fit" replacement for a competitor's motor. Although motor constant does not address thermal or other viscous losses, it is still useful for getting one into the "ballpark." Regarding motor constant:

- Motor Constant is a ***figure of merit used to compare the relative efficiencies and output power capabilities of different motors. Km defines the ability of the motor to transform electrical power to mechanical power.***
- Motor Constant is calculated by the following equation (in English units):
  - **Km = Kt/√Rt** - where Kt is the torque sensitivity (oz.-in./amp) and Rt is the terminal resistance (ohms)
  - Units for Km are **oz.-in./√watts** (in English units)
- As can be seen from the above equation, the lower the motor's resistance the higher the Km will be.
- **Physical motor size can be deceiving!** It is sort of intuitive to think a much larger motor will be more powerful than a smaller motor but this may not be the case. How then would we determine which is the more powerful motor? By calculating the motor constant.
- Customers are notorious for not providing complete specifications, making it difficult if not impossible to recommend a best fit alternative. However if we can get the customer to share the **KT** and **RT** of the motor, using the equation for calculating motor constant, we can make a relatively good recommendation.
- Knowing how to calculate motor constant is invaluable in trying to recommend a best fit equivalent for competitor's units.

Now that the background is in place, let's put this new-found knowledge to work:

Example #1:

Using the MCG Motor Catalog (and without peeking), calculate the motor constant for a BN23-28MG-01LH

This motor has a KT of 4.26 oz.-in./amp and a RT of 0.181 ohms. *KM = KT/√R = 4.26 oz.-in./amp/√0.181 ohms* = **10.01 oz.-in./√watts**

Example #2:

A **C34-L70W10** is 3.16 inches in diameter and 7.0 inches long. The volume of this motor is **54.5 cubic inches**.(treating the motor as a cylinder). A **BN34-35AF-02LH** is 3.40 inches in diameter and 3.50 inches long. The volume of this motor is **31.7 cubic inches** (again treating the motor as a cylinder). The C34-L70W10 is obviously a much larger motor. Which motor however is more powerful?

Using KM, the C34-L70W10 has a KM of **20.82 oz.-in./√watts.** The BN34-35AF-02LH has a KM of **25.87 oz.-in./√watts.** From this you can see the much smaller motor is more powerful than the larger motor.

Example #3:

A customer comes in looking for a best fit replacement for a SLMTI motor. The motor data is as follows:

Winding Data at 48 VDC (Approximate)

PARAMETER	UNITS	VALUE
Torque Constant, K_t	oz-in/A	**5.9**
Voltage Constant, K_e	V/kRPM	**4.37**
No Load Speed, NLS	RPM	**10992**
Electrical Time Constant, t_e	mS	**0.43**
Mechanical Time Constant, Sensorless, t_m	mS	**6.01**
Mechanical Time Constant, w/Halls, t_m	mS	**6.46**
Resistance at 25°C, R_m	Ohm	**2.34**
Inductance, L_m	mH	**0.99**
Max. Continuous Power Output at 100°C Rise	W	**78.59**
Max. Continuous Torque Output at 100°C Rise	oz-in	**11.07**
Max. Continuous Speed Output at 100°C Rise	RPM	**959**

What MCG brushless motor would you recommend as a best fit replacement?

Using KM as a figure of merit, we see the SLMTI motor has a KT of 5.9 oz.-in./amp and a RT of 2.34 ohms. Calculating KM we find this motor has a **KM of 3.86 oz.in./√watts.** When we recommend an alternative motor we want to match the KM as closely as possible - to insure the power is equivalent - as well as match the KT as closely as possible - to insure the speed is equivalent. So I'm going to look for a brushless motor with a KM as close to 3.86 oz.-in./√watts and a KT as close to 5.9 oz.-in./amp as possible. My recommendation would be:

BN23-13MG-03LH - this motor has a KT of 5.18 oz.-in./amp and a KM of 3.77 oz.-in./√watts.

The customer may need a slight winding adjustment to get closer but this is a good baseline from which to start.

Example #4:

You might want to try this one on your own! A customer has sent in the following data for a Bodine **brush motor** but wants to replace it with a **brushless motor**. What brushless motor would you recommend? (Caution - look at the units - conversions may be necessary!):

Specifications

Model Number	6230 [CAD Drawings]
Category	180V, Metric Mounting Provisions
Speed (rpm)	3000
Rated Torque (Nm)	.50
Amps	1.1
Motor Watts	155
KT (Nm/A)	.52
KE (V/krpm)	53
Winding Resistance (ohms)	15.9
Winding Inductance (mH)	N/A
Armature Inertia (kg-mm2)	270
Radial Load (N)	240
Length XH (mm)	158.9
Weight (kg)	3.1
Product Type	33A5BEPM
Winding	180V
Accessory Shaft	NO
Connection Diagram	074 10097

In recapping KM - Motor Constant:

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Hope this was helpful! More to come….

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