CALLAN TECHNOLOGY NEWS

ISSUE 4, 2008

Callan Technology Ltd is a design and manufacturing company for a wide range of industrial DC servomotors, tachogenerators and components. Callan Technology's industrial motor platform (M4 range) is a family of rare earth permanent magnet DC servomotors:

M4-200X (0.4 – 1.6 Nm)
M4-295X (2.0 – 8.1 Nm)
M4-420X (10.4 – 30 Nm)

C4-16X is a new family of compact, rare earth servomotors specifically designed for applications where low cost is important while maintaining ruggedness and performance. Two basic lengths are available with continuous torque of 0.2 & 0.4 Nm resp.

We customise our motors to your requirements – special windings, mount/shaft, connection, feedback, sealing etc. – this is our strength and more than 80% of our products are tailored to your specific requests.

nsai
National Standards Authority of Ireland

Certificate of Registration of Quality Management System to I.S. EN ISO 9001:2000

The National Standards Authority of Ireland certifies that

Callan Technology Ltd
Bay K, 12a/b
Shannon Industrial Estate
Shannon
Co. Clare

has been assessed and deemed to conform with the provisions of the above standard in respect of the scope of operations given below.

Scope of Registration

The design and manufacture of servomotors

Registration Number:	19.5020
Original Registration:	08 April 2008
Last Amended on:	08 April 2008
Remains valid until:	07 April 2011

Signed:

Patrick Breen – Director of NSAI Client Services

NSAI is a partner of IQNet – the international certification network (www.iqnet-certification.com)
The validity of this certificate is maintained through on-going surveillance inspections.
Issued on 11 April 2008
National Standards Authority of Ireland, Glasnevin, Dublin 9, Ireland

Callan Technology was recently awarded ISO 9001: 2000 certification after audit by National Standards Authority of Ireland (NSAI) – registration No. 19.5020. The registration covers both design and manufacture of servomotors.

The success in achieving the ISO registration follows continued dedication by the staff at Callan Technology to producing the highest possible quality products.

Callan Technology is committed to providing quality servomotors, with on-time delivery at the right price to our customers. We have implemented a range of lean manufacturing and reporting techniques within our facility. We maintain strong emphasis on continuous improvement to meet our Quality, Delivery and Cost targets.

IF YOU WANT TO CONTINUE TO RECEIVE A COPY OF CALLAN TECHNOLOGY NEWS, PLEASE SEND AN EMAIL WITH "SUBSCRIBE" TO **INFO@CALLANTECHNOLOGY.COM**

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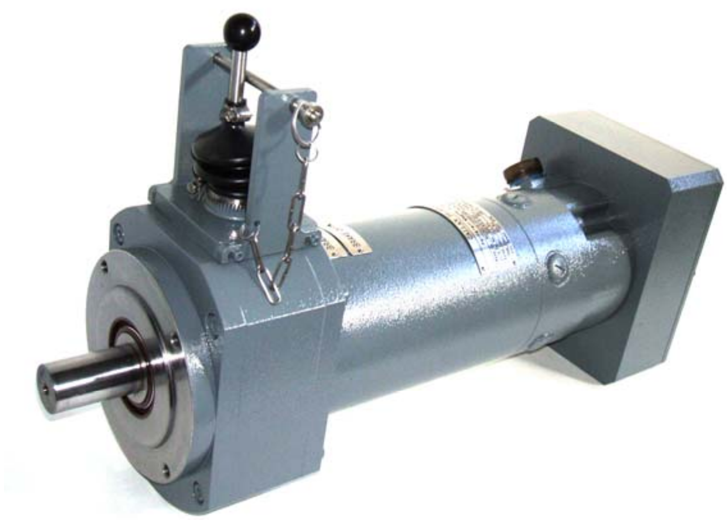
Engineered to Order - Case Study

A major manufacturer in the antenna & satellite control systems industry recently approached Callan Technology with a specification for a highly customised DC servomotor for a special project.



Among the primary requirements were :

- Entire motor sealed IP65
- Special shock (EN-60068) & vibration (MIL STD 167-1) spec.
- Anti-corrosion motor finish with customer specific paint and nameplate specifications
- 24 V DC failsafe brake with emergency release handle and locking
- Brushless resolver feedback with gearing to motor shaft
- Connectors to MIL-C-38999
- Thermostat (NC)

Following from comprehensive design review with the customer, Callan Technology was able to construct a qualification prototype using the M4-4207 (24 Nm) motor design. A complete set of design verification tests were performed on the qualification motor, including IP65 sealing, motor rating (continuous & peak), feedback (performance & gearing), holding brake operation & emergency hand release function, vibration & shock performance and anti-corrosion motor finish. Following successful completion of validation testing, production for the project motors commenced and was completed on time to the customer requirements.

Callan Technology - Distributor Focus

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DC Servomotors Tutorial :
Torque Constant (Kt) and Back EMF Constant (Ke)

Torque Constant (Kt) and Back EMF Constant (Ke) are widely used when comparing servomotors or choosing a servomotor for an application. In spite of their simplicity, there can be considerable confusion regarding these two very important servomotor parameters.

Is Kt exactly equal to Ke or just approximately equal?
Why is Kt substantially different to Ke in some servomotor catalogues?
What are the implications of the relationship between Ke and Kt?
How are these parameters measured in practice?

The following discussion and formulae relate to the permanent magnet DC (brush) servomotor.

Back EMF Constant (Ke) is defined as the back EMF (E) per unit shaft speed (n)

$$Ke = E / n$$

In metric (SI) units, E is measured in volts and speed in rad/s so Ke has the units of V/rad/s. In Imperial (English) units, E is measured in volts and speed in krpm so Ke has the units of V/krpm. (In some literature Back EMF Constant is denoted Kb and the symbols Ke and Kb may be used interchangeably)

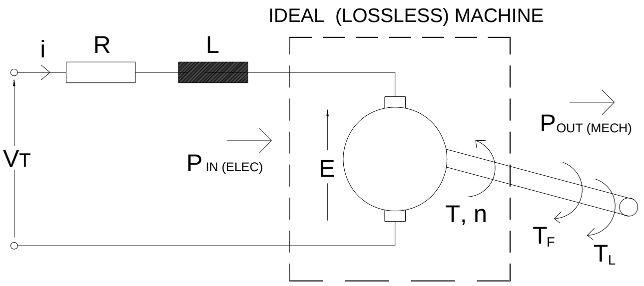
Torque Constant, Kt, is defined as developed or electromagnetic torque, T, per ampere of motor current, I

$$Kt = T / I$$

In metric (SI) units, T is measured in Nm and current in amps so Kt has the units of Nm/A.
In Imperial (English) units, T is measured in lb.in and current in amps so Kt has the units of lb.in/A

These two constants are intrinsically related. The simplest way to determine the relationship is by power considerations on an equivalent model of the motor

Equivalent Circuit Model.



Consider the motor supplied by a terminal voltage (V) supplying a current (I) so that the motor develops a steady torque (T) at speed (n). All motor losses (iron loss, copper loss, windage, friction, brush voltage drop) are modelled by a single resistance R whose power dissipation at current I equates to the motor input losses. Therefore the electrical power into the ideal motor (devoid of its losses), Pin (elec) = E I (watts).
The mechanical output power of the ideal motor, Pout (mech) = T n (watts)
Since these are the input and output power of the ideal motor (stripped of its losses), it follows

$$\text{Pin (elec)} = E\,I = \text{Pout (mech)} = T\,n$$
$$\Rightarrow E\,I = T\,n$$
$$\Rightarrow \text{Ke (V.rad/s) n (rad/s) I (A)} = \text{Kt (Nm/A) I (A) n (rad/s)}$$

$$\Rightarrow \textbf{Kt (Nm/A)} = \textbf{Ke (V/rad/s)} \quad \ldots(1)$$

Therefore it follows that Kt is exactly identical to Ke when the constants are expressed in metric (SI) units.

When the calculations are performed in Imperial (English) units, the relationship becomes

$$\textbf{Kt (lb.in/A)} = \textbf{Ke (V/krpm) / 11.83} \quad \ldots\textbf{(2)}$$

It is quite common to use mixed units of torque in Nm and speed in krpm and in this instance the relationship becomes

$$\textbf{Kt (Nm/A)} = \textbf{Ke (V/krpm) / 104.7} \quad \ldots\textbf{(3)}$$

Measurement & Temperature Effects

Back EMF Constant, Ke can be measured by backdriving the motor (as a generator) at a steady speed and measuring the open circuit (generated) voltage. Since no current is flowing in the motor, the brush drop is essentially zero and the measured voltage is equal to the motor back EMF at the set speed. Ke is then calculated by dividing the measured voltage by the speed (in the chosen units).

A less accurate method to measure the value of Ke is to run the motor from a fixed supply, V and measure the no-load speed. Since the no-load current is not zero, the terminal voltage is not exactly equal to the back EMF. However the result can be corrected to give an accurate value of Ke if the resistance drop (I R) and the brush drop are subtracted from the value of terminal voltage V. Since this test is relatively simple and quick to perform, it is normally conducted as a production quality check to ensure that manufactured motors exhibit Ke and Kt within the specified tolerance value.

Direct measurement of Torque Constant, Kt is more difficult. For this reason Kt is usually deduced from Ke as described. Kt can be measured by mounting the motor on a dynamometer (controllable load with in-line torque and speed sensors). With the motor driving a medium value steady load (typically the motor rated continuous torque), the torque constant can be evaluated as the ratio of shaft torque and motor current. The indicated value of shaft torque must be corrected by adding the friction torque so that the torque value in the calculation is the developed or electromagnetic torque. The set value of load torque must not be excessive otherwise the value of Kt is decreased by armature reaction (saturation of the motor steel at higher level of armature current).

In conducting this test the motor temperature rises due to the armature current so it is necessary to wait until the motor reaches its ultimate (settled) temperature for the set load. Therefore the Kt value is normally measured for the "hot" motor, where the windings and magnets have reached their rated temperature. The (Back EMF constant, Ke, by contrast is normally measured and recorded for the motor at ambient temperature of 20°C.) When Kt is measured or catalogued for the "hot" motor condition, equations (1), (2) & (3) must be modified as

Kt (Nm/A) = K1 Ke (V/rad/s) …(1)

Kt (lb.in/A) = K1 Ke (V/krpm) / 11.83 …(2)

Kt (Nm/A) = K1 Ke (V/krpm) / 104.7 …(3)

K1 represents a lowering of the magnetic flux of the permanent magnets at the hot condition. This reduction in flux is reversible and therefore fully recovered once the motor cools down to ambient temperature. K1 depends on the permanent magnet material, the rated thermal class of the motor and to a lesser extent, the construction geometry of the motor design. All Callan Technology motors use rare earth permanent magnets which exhibit low temperature coefficient of motor flux and therefore K1 is typically 0.97 – 0.99.

The relationship between Ke & Kt has practical implications for the choice of motor winding. It is possible for the design engineer, when considering winding offerings for a given motor size (frame size & magnet length) and hence torque rating to provide winding choices with wide variety of coil-turns and hence, Ke value. A winding with higher Ke value will have higher Kt value and therefore can achieve rated torque at a lower value of rated current (T/Kt). This is desirable in order to minimise the size & cost of associated servodrive. However the resultant high value of Ke necessitates that a lower value of no load speed (V/Ke) can be achieved for a given supply voltage. This shows that for a given motor, there is a compromise when choosing a winding offering, between max speed and minimum rated current.

As an example, the table below shows three winding options for a M4-2004 motor. This motor has a continuous torque rating of 0.9 Nm (all windings). Windings with higher Ke (and hence Kt) exhibit lower value of rated current (Ic) required to achieve 0.9 Nm but achieve lower value of no-load speed at the max supply voltage of 90 V .

M4-2004 (Tc = 0.9 Nm)				
Winding	Ke (V/krpm)	Kt (Nm/A	Ic (A)	N no-load (rpm)
A	15.6	.148	6.3	5,770
C	21.3	.201	4.6	4,225
R	26.0	.246	3.8	3,460

AfterMarket Focus

Motor:	**M4-4204-04C-057**
Originally used on:	Sima Rope/Twine Machine
Body Diameter:	146mm
Length:	262 mm
Shaft Ø	19g6x 50.8 with keyway (DIN 6885)
Connection:	Pg11 cable gland (1.5 m leads)
Feedback:	No feedback
Continuous Torque (Tc):	13.6 Nm

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