CALLAN TECHNOLOGY NEWS

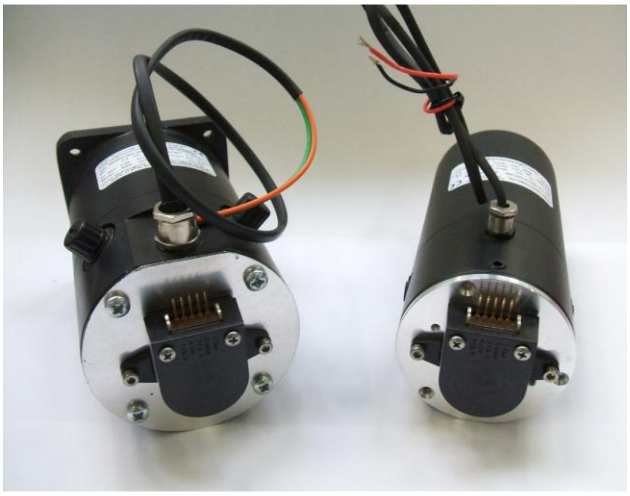
ISSUE 1, 2009

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)

All motors are available in a variety of shafts & mounts, connection types, tachogenerator or incremental encoder feedback, parking brake and a variety of other special features. The use of rare earth magnets results in compact motors with favourable power/weight ratio compared to conventional ferrite motors.

C4-16X is a family of compact, rare earth servomotors specifically designed for applications where low cost is important while maintaining ruggedness and performance. Typical applications include door opening, wafer spinning, office machines, X-Y tables, CMM's etc.



The C4-16X and M4-200X motor families have recently had their range of optional features enhanced with the release of a new low cost modular encoder.

Two styles of modular encoder are offered:

1) +5V, single ended (5 pin), 2 channel TTL output with index
2) +5V, differential (10 pin), 2 channel output with index.

The standard offering gives the option of 512, 900 or 1024 cycles per rev but a wide range of other line counts can be offered upon request up to a maximum of 1250 lines at 100,000 cycles per sec.

The modular encoder option is extremely compact (17.5mm additional length) and accepts widely available AMP mating plug. Mating plugs and cables can be offered upon request.

For further details see http://www.callantechnology.com

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Engineered to Order - Case Study

Callan Technology recently completed a new design project to prepare a motor for precision centrifuge application. Among the primary requirements were

- Custom motor mount & shaft size
- Stainless steel hollow shaft
- Elevated max speed
- Very low operational noise
- Low drive end shaft runout
- Reduced motor length
- High altitude brushes

Callan Technology was able to meet the customer requirements using a highly customised C4-161 (0.2 Nm) motor design. The C4-16X is a compact, rare earth servomotor family providing ruggedness and performance where low cost is important.

The use of rare earth magnets provided a solution with excellent thermal stability.

Full scale production commenced after successful approval of a trial prototype at the customer test department.

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DC Servomotors Tutorial –
Rated Torque and Winding Temperature Measurement by Resistance Method.

DC servomotors exhibit a continuous or "rated" torque characteristic. This characteristic line on a torque-speed curve, denotes the maximum continuous torque a motor can produce (at each speed) without risk of damage due to overheating. At low speed, the value is referred to as the Rated Stall Torque and at the motor nominal speed it is referred to as the Rated Torque or the Nominal Torque. The rated torque characteristic is experimentally measured by the manufacturer and is ultimately determined by the permissible temperature of the motor winding and its insulation system.

Motor insulation systems are classified by their thermal capability. Four insulation classes are most commonly used, denoted A, B, F & H.

Insulation Class	Temperature Rating
A	105°C
B	130°C
F	155°C
H	180°C

The temperature rating of each class defines the maximum temperature at which the insulation can be operated to yield an average life of typically 20,000 hours. (Note the gap of 25°C between the different insulation classes.)

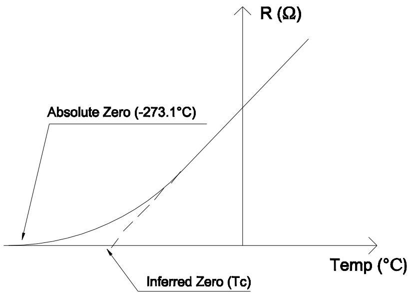
Many insulation components are used in the process of building an electric motor and the classification of the insulation system is based on the lowest rated component used in the motor. For example, if one class B component is used along with class F & H components, then the entire system must be called class B.

In order to determine the rated torque of a motor it is necessary to measure the temperature rise of the motor winding caused by a test value of load torque. The value of load torque which causes an ultimate (settled) winding temperature to reach the limits of the Insulation class defines the rated torque of the motor.

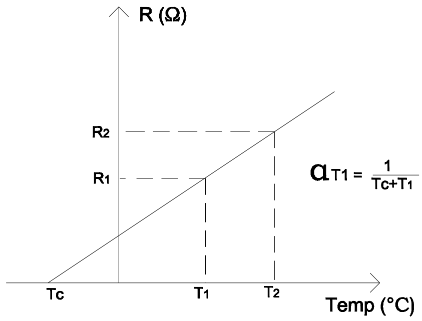
<u>Temperature Measurement by Resistance Method.</u>

The resistance of a metallic conductor is a linear function of temperature over a wide range. As the conductor temperature approaches "Absolute Zero" (-273.1°C), the function ceases to be linear. Throughout the linear region, the function behaves as if resistance is zero at Tc °C ("Inferred Zero").

For 100% conductivity copper wire, inferred zero is found to be -234.5°C.



Therefore we can consider resistance as a linear function of temperature on a centigrade scale as shown below.



By geometry it can easily be shown that

$$R_2 = R_1 [1 + \alpha_{T1} (T_2 - T_1)] \quad .... (1)$$

α_{T1} is the temperature coefficient of resistance referred to temperature T1. With T1 = 20°C, α_{T1} = 0.00393

Eqn. 1 is useful when R_1 is known at temperature T_1 (as in the case of a wire table at standard temp. (eg. 20°C) and R2 must be determined at some other temperature T2.
Alternatively Eqn. 1 can be used to convert a resistance measurement R2 at some elevated temperature T2, to a resistance at a standard temperature T1, provided the correct value of α_{T1} is used.

Eqn 1 is also useful when the resistance is known at standard temperature T1 and also at some elevated temperature T2 but the value of the elevated temperature T2 needs to be determined. In this instance, Eqn. 1 can be rewritten as

$$\Delta T = T2 - T1 = [(R2 - R1) / R1] [234.5 + T1] \quad .... (2)$$

Rated Torque Measurement

Motor resistance, R1, must be measured with the motor in thermal equilibrium at ambient (room) temperature, T1. This measurement is made by four wire method, with all brushes removed, on a fixed pair of commutator bars (typically one pole pitch apart). Next the motor is placed on a dynamometer (controllable load with torque & speed sensors) and a fixed torque (current) equal to best estimate of rated torque is placed on the motor shaft. The motor current is maintained until the winding has reached a settled temperature rise above ambient. At some instant (time t=0), the motor current is cut, all brushes removed and 4 wire resistance measurement set up on the same two bars. Since the armature will have cooled somewhat before the first hot resistance measurement can be obtained, it is necessary to continue taking hot resistance measurements (separated by some reasonable time intervals) so that the results can be graphed and extrapolated back to time t = 0 (the elevated motor resistance R2, at time on current shutdown). Eqn 2 may now be used to calculate ΔT, the temperature rise of the motor winding above ambient resulting from the test value of load torque.

Comparisons of Rated Torque Data

The vast majority of industrial servomotors are rated to a class F, natural ventilation specification. However any comparisons of different motors on the basis of rated torque can be very biased if the measurement assumptions for each motor are not identical.

First Eqn 2 shows that motor torque causes a winding temperature rise above ambient. Therefore if the ambient conditions of testing are not similar for both motors, a false comparison results.

For a Cl. F motor it is common to test in a 25°C ambient to a winding temperature rise **ΔT** = 130°C (155°C ultimate temperature**).** However many data sheets give ratings for 40°C ambient (with permissible rise of 115°C). By manipulation of Eqn. 2, it can be shown that a given motor must be derated by approx 6% when data is required for operation in 40°C (ΔT = 115°) compared to a rating in 25°C ambient (ΔT = 130°C).

A further bias between different motors may result when target value of temperature rise used to determine rated torque differs between different motors. In North America, it is quite common for servomotor manufacturers to determine rated torque when the winding temperature is at the full limits of its Cl. F insulation (ΔT = 130°C over 25°C ambient) In Europe, it is more common for manufacturers to provide some temperature headroom at the rated condition with a typical rating corresponding to ΔT winding = 100°C over 25°C ambient (leaving 30°C headroom between winding temperature at rated condition and the ultimate capability of a Cl. F winding). It can be shown that a given motor must be derated by approx 8% for the condition ΔT winding = 100° over 25°C ambient as opposed to the condition ΔT = 130°C over 25°C ambient.

It is standard practice to mount a test motor to a metal plate of given thickness and area, to act as a heat sink. For short motors, the type and size of heat sink can be very influential upon the obtainable rating. Unfortunately very few standards exist for recommended plate sizes for given motor sizes and this may lead to biased comparisons of rated torque between different motor manufacturers.

AfterMarket Focus

Motor: **M4-2952-1B-3511**
Originally used on: Mikron (Machine Tool)
Body Diameter: 108mm
Length: 246 mm
Shaft:- Ø0.625” (15.875 mm)
Square Flange (IMB5)
Shaft Seal
Tachogenerator:- 12.5 V/krpm